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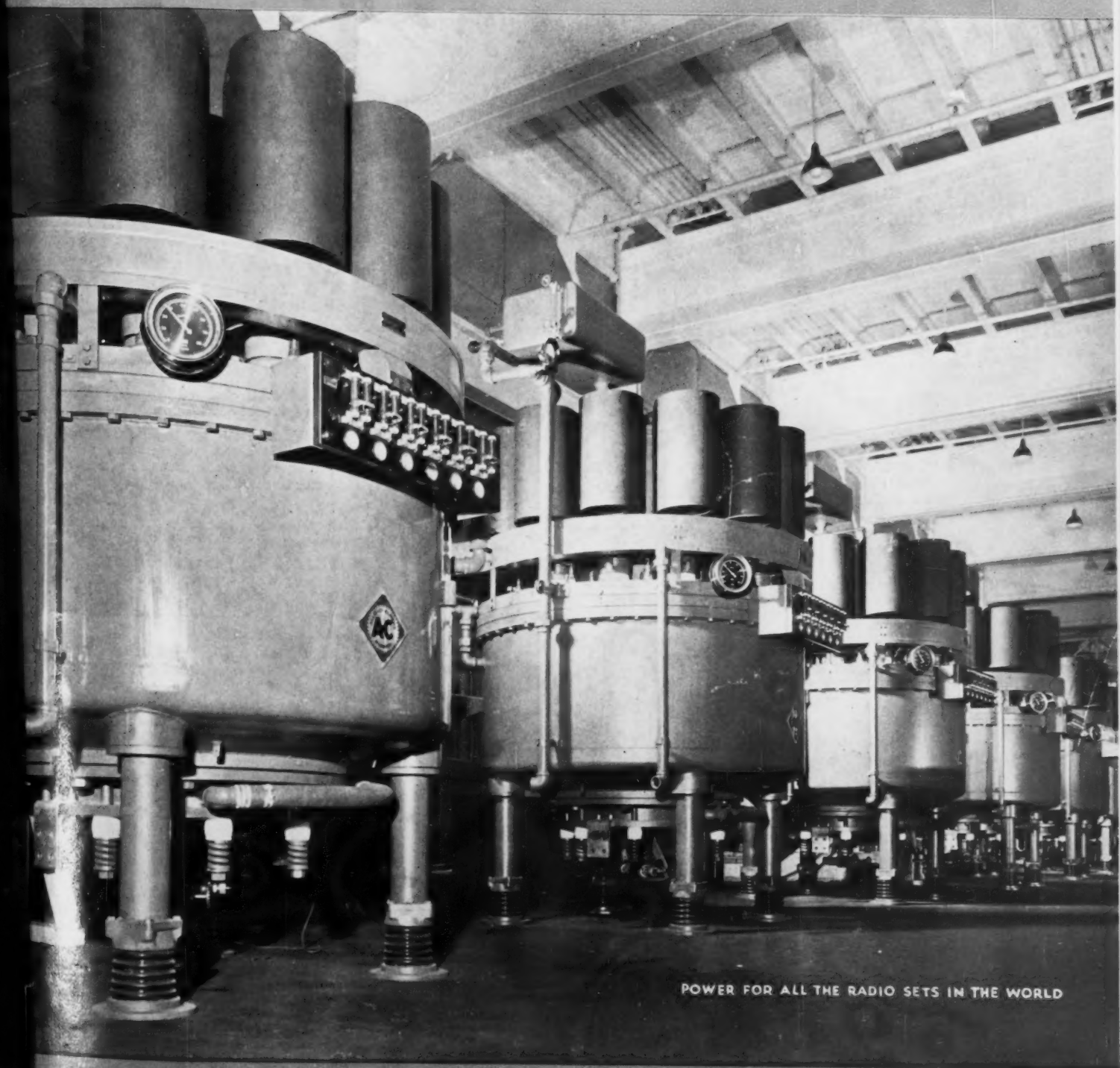

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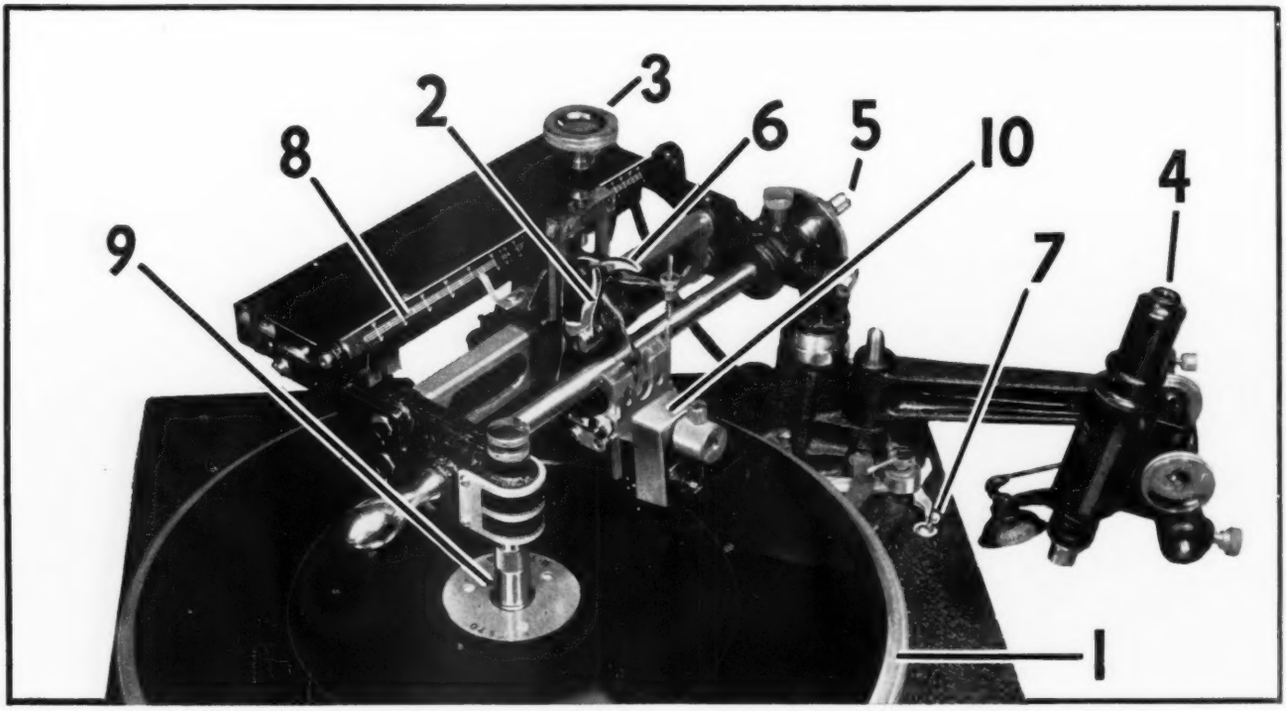

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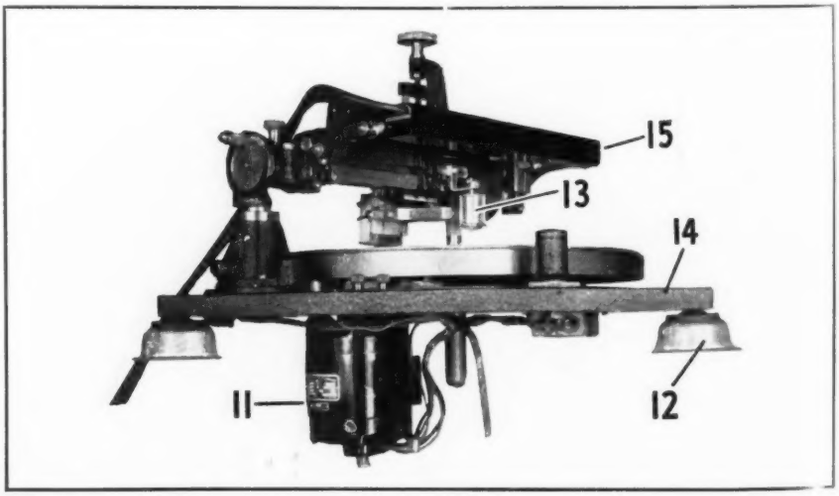

PRESTO

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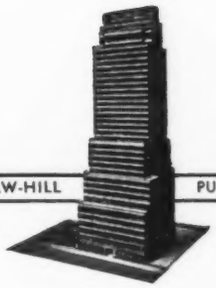

A McGRAW-HILL PUBLICATION

electronics

RADIO . . . COMMUNICATION AND INDUSTRIAL APPLICATIONS OF ELECTRON TUBES . . . DESIGN . . . ENGINEERING . . . MANUFACTURE

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ELECTRONICS, May, 1939, Vol. 12, No. 5. Published monthly, price 50c a copy. Subscription rates—United States and possessions, Canada, Mexico and Central American countries, $5.00 a year. All other countries, $8.00 a year or 24 shillings. Entered as Second Class matter, August 29, 1936, at Post Office, Albany, N. Y., under the Act of March 3, 1879.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

Contents Copyright, 1939, by McGraw-Hill Publishing Company, Inc.

McGRAW-HILL
PUBLISHING COMPANY, INC.

JAMES H. McGRAW
Founder and Honorary Chairman

Publication Office
99-129 North Broadway, Albany, N. Y.

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MCGRAWHILL, New York
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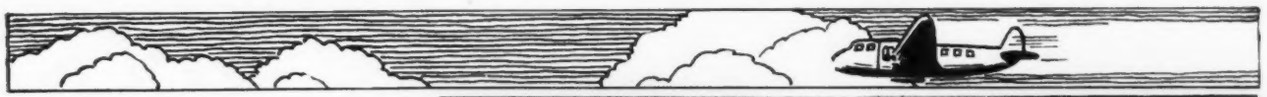


The SEA-TRACK EARTH INDUCTOR COMPASS . . .

This recently perfected earth inductor compass for boats, and its counterpart SKY-TRACK for airplanes, will not spin, precess or waver, and has the important advantage of returning to a proper reading, after pitching, rolling, banking and bumping, in less than half a second. It is a product of the AIR-TRACK MANUFACTURING CORPORATION, Washington, D. C.

Another new application of an S. S. WHITE Remote Control Flexible Shaft

WRITE FOR ENGINEERING BULLETIN 38

It gives full information about S. S. WHITE Remote Control Shafts and the wide range of sizes and physical characteristics in which they are made. Also tells how to select shafts for specific conditions and how to apply them. A request on your business letterhead brings a free copy.

For remote control of this vastly improved earth inductor compass, a flexible shaft is needed that is non-magnetic, has a minimum torsional deflection per foot of length, and will function dependably in lengths from 6 to 25 feet.

The manufacturer reports that the S. S. WHITE Remote Control Flexible Shaft used, "meets these specifications to our entire satisfaction."

This instrument adds one more to the long and growing list of applications of S. S. WHITE Remote Control Flexible Shafts, and provides further evidence of the ability of these shafts to satisfy exacting conditions.

When you have a mechanical remote control problem, remember that S. S. WHITE will be glad to cooperate in selecting the proper shaft and engineering its application. No obligation. Write us.

S. S. WHITE

The S. S. White Dental Mfg. Co.

INDUSTRIAL DIVISION

Department E, 10 East 40th St., New York, N. Y.

ELECTRONICS

MAY
1939

KEITH HENNEY
Editor

Crosstalk

▶ **LETTERS** . . . Editors get strange letters, now and then. Sometimes they are mighty difficult to answer. Anyone having anything to offer on the following problems should address the editor:

A reader in Maryland states "I would like to build an 'oomph' meter. They use this at a lot of colleges to measure the umph generated when two people kiss." Could this be a kind of lie detector?

Here's another, "How do you explain the rotation-translation movement of the earth? Points A and B on the equator are 0.465 (really 0.505) km, 1 inch, apart and correspond to A and B on the ecliptic, 29.78 km apart. Intermediate points all contact the ecliptic. How then do you make 29.78 out of 0.465? Does the earth mostly skid along?"

Here's another—this one seems to be a serious matter. "There has been an extortion racket on my home for several months, whistle beam—paranoid murder suggestion, perhaps without a secondary motive of locking in a secondary whistle vibration and a possible false claim on help. How about searching out the source of the paranoid beam?"

We get lots of requests for dope on oil and ore finders. It is amazing how many people's grandfathers are reliably believed to have hidden the family plate in the backyard when the Red Coats were coming. Now here's a reader who seems to have what everyone has been looking for. He has a dingus which locates elements selectively by their radiations. He lives in Denver and states "I found a silver mine in Missouri from here and went to it last fall. The chimney is 17 ft. in diameter and a 56 foot beam crosses it 100 feet below the surface and extends 7½ miles into the earth. I could detect the mint here in Denver from Los Angeles." He wants to know prices paid and what he would be charged for small amounts of each of the 92 elements.

▶ **LOG** . . . Cleaning house the other day we ran across an evening's entry in the station log book of WJZ, November 1921.

7.55–8.05 PM	Two tests records on Edison phonograph
8.10–8.15	Newark Sunday Call news read by Thomas Cowan
8.15–8.18	Stand by 3 minutes, all quiet
8.20	Sacred selections on Edison phonograph
8.30	Stand by three minutes
8.35	Sacred selections on Edison phonograph
8.50	Stand by three minutes KZN and WNY
8.55	Sacred selections on Edison phonograph
9.15	End of concert. WJZ signing off
9.50	Explain Arlington time signals
9.55–10	NAA time signals
10.05	Weather forecast
10.10	WJZ signing off
10.25	Played an Edison record for Watton 2BZH (a local amateur, the gentleman who installed Westinghouse receivers).

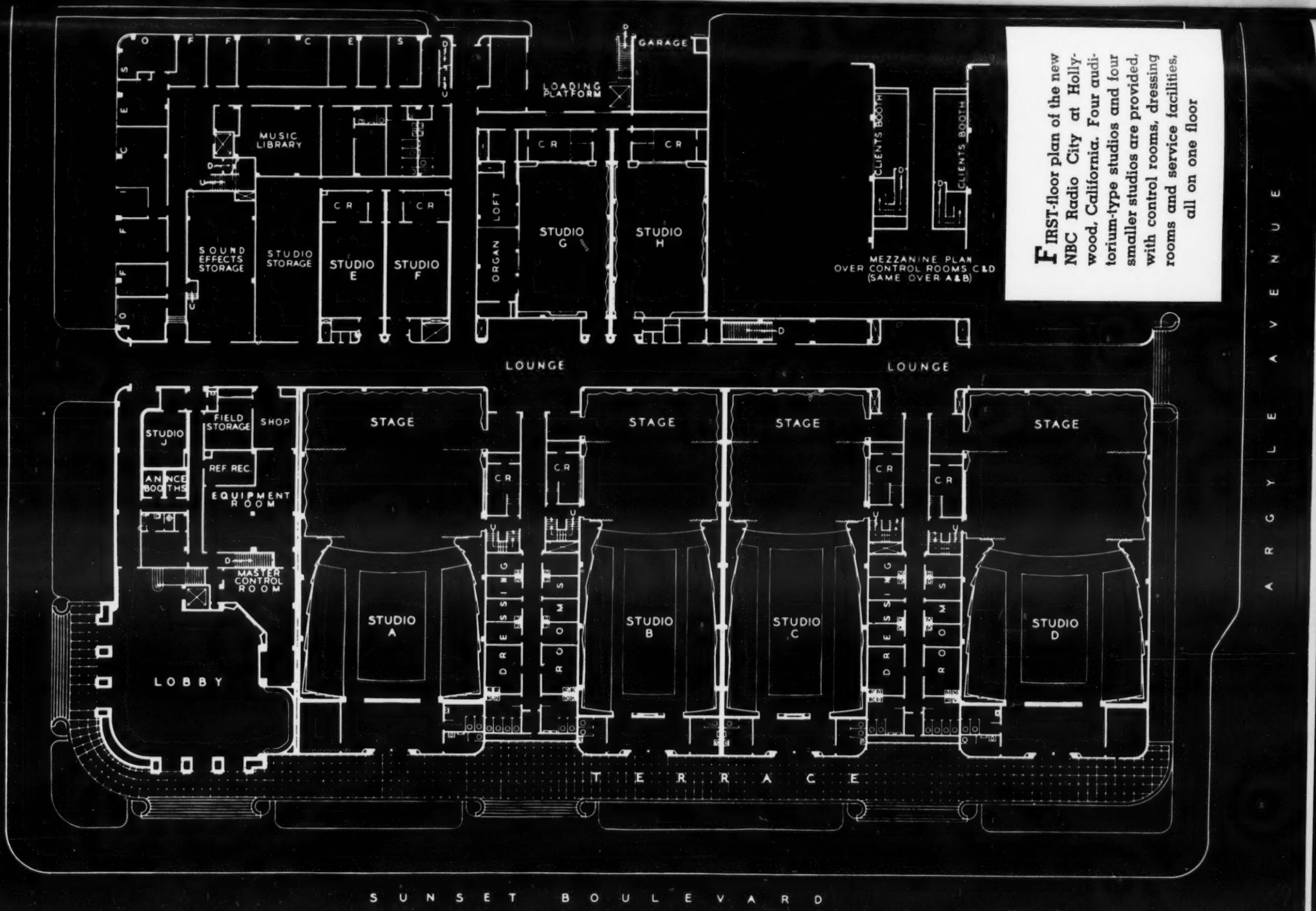
▶ **C.W.** . . . Craig Walsh, brother of the well known consulting radio engineer Lincoln Walsh, has joined the editorial staff of *Electronics* after several years experience in the Arcturus and National Union radio tube laboratories. A Stevens graduate, Mr. Walsh will run errands, and be general flunky until he gets on to the ropes of the publishing business.

P.S. Mr. Walsh is already beyond this stage. His first story in *Electronics* appears this month, the article on the new fangled fasteners that seem to be saving money and trouble in making radio sets and other electronic apparatus. A full engineering description of Lincoln Walsh's high fidelity receiver will be another of Craig's contributions to appear in an early issue.

▶ **NICK** . . . Newspapers have already told the story of how Phil Farnsworth's people intend to build television receivers in the Capehart factory at Fort Wayne and in the General Household Utilities plant at Marion, Ind., and how they will continue the Capehart line of radio-phonographs. Head of the new firm is E. A. Nicholas, long time manager of the license division, RCA.

Nick gave us our first job in radio, and a bum job it was. We got $25 a month in those days operating old United Wireless equipment of the Great Lakes. The spark gap made so much racket the passengers kicked; the radio shack was unheated and to keep warm we charged batteries all day through voltage dropping resistors. A hundred-mile reception was a record. The second year we got $30 per month and made so much trouble about heat the engineer put in a radiator. Heat is a serious problem in Lake Superior where you can toss a bucket overboard and haul it up by a rope to have drinking water that is 38 degrees cold the middle of June.

Later on we got a really swell job through Nicholas. This was on a Shipping Board vessel which had to come down from Superior, Wisconsin, where she was made, to salt water. As we remember, out of a three months job we were under way only about 14 days. The rest of the time we went fishing.



FIRST-floor plan of the new NBC Radio City at Hollywood, California. Four auditorium-type studios and four smaller studios are provided, with control rooms, dressing rooms and service facilities, all on one floor

NBC, HOLLYWOOD

By C. A. RACKEY
Audio Facilities Engineer

R. F. SHUETZ
Audio Facilities Group
National Broadcasting Company

A MODERN studio plant for radio broadcasting is an enterprise of wide scope. Its conception, planning, and construction involve four major classifications of effort; commercial administration, architecture, mechanical engineering, and broadcast equipment engineering. NBC's newest studio plant at Hollywood is an example of such an enterprise; it can best be described by reviewing the major details comprising the development of a typical plant of this type.

The accompanying floor plan (facing page) indicates the space arrangement of the new NBC Hollywood plant. Studio audiences are an important factor in Hollywood broadcasting and ample facilities have been provided for this purpose. Four large auditorium type studios are included, two of them 104 ft. x 58 ft., with stages of 50 ft. x 58 ft.; the other pair is 108 ft. x 45 ft. with stages of 45 ft. x 48 ft. In addition two pairs of smaller studios are provided, two 20 ft. x 30 ft. and two 30 ft. x 50 ft., one of which has an organ loft, with a pipe organ installed therein. Appurtenant spaces for broadcasting include two booths for announcements which are unrelated to a program, and an electrical transcription studio.

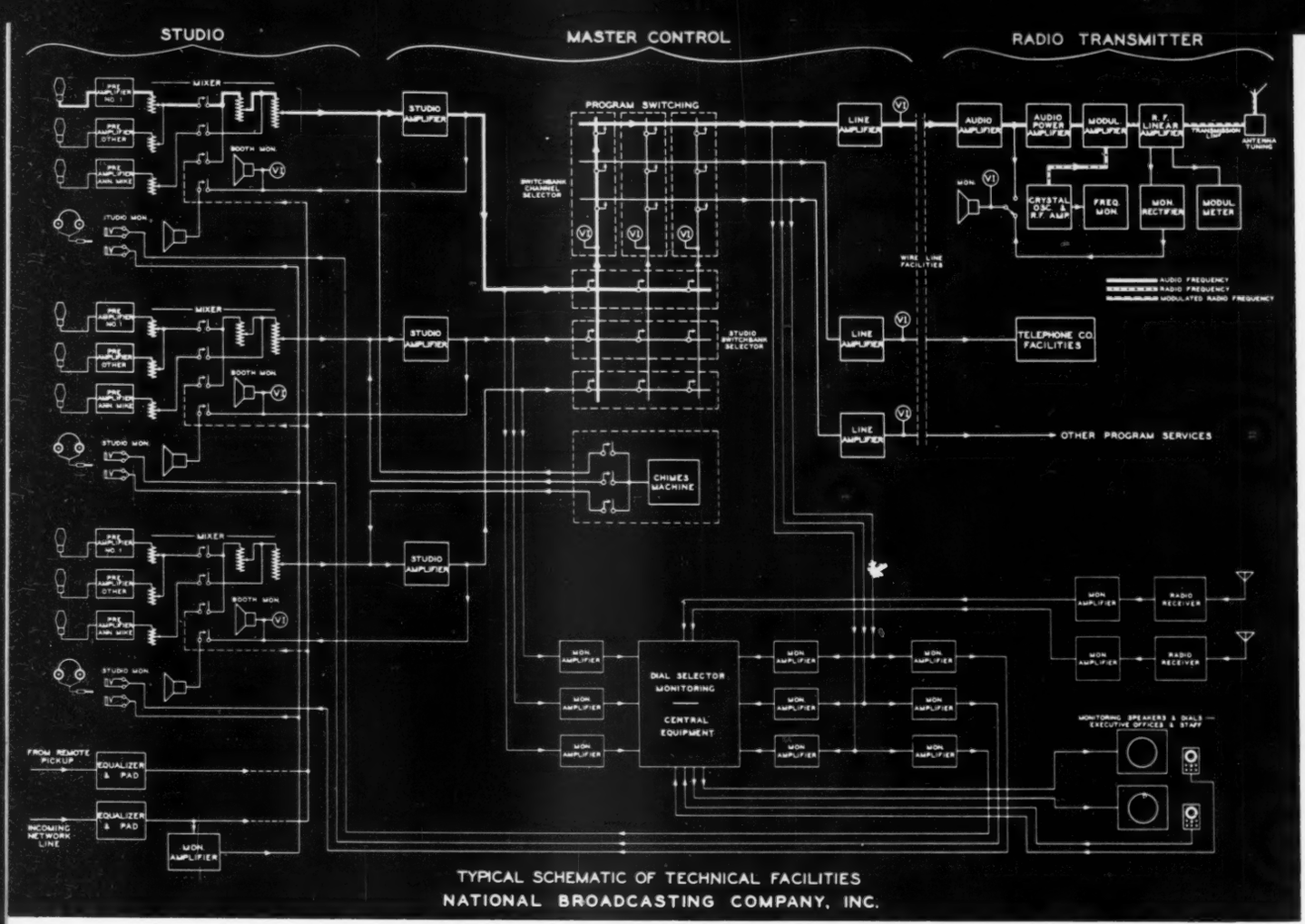
Four important factors combine to make the horizontal layout especially desirable. It increases operating efficiency as all important activities are on one level; it is obviously an economical form of construction; it provides a very satisfactory means of sound isolation between studios since each is constructed practically as a separate unit; and it eliminates confusion in handling studio audiences.

A glance at the sketch indicates the convenience inhering in such space arrangement. A central corridor of ample size provides access to all studios and adjoining spaces. This corridor runs the entire length of the building, an entrance being provided at either end.

Studio audiences, a most important feature in Hollywood broadcasting, are admitted from a terrace which runs lengthwise along the street side of the building structure. A canopy built as part of the structure runs the entire length of the terrace and provides protection from the elements.

From a construction standpoint the economy in framing of a single level unit as compared with one of two levels is considerable. To this saving may be added the space required for, and cost of, construction of stairways and elevators. It should be noted also that with the exception of the organ studio where extra precautions were desired, no floating type soundproofing is employed, the desired isolation being obtained by building each studio as a separate structural unit. At such points where these separate structures are contiguous, or where adjacent structural elements bear upon them, cork strip insulation is employed to eliminate a direct physical connection.

The Master Control Room, where the program switching controls and transmission test equipment are installed, is located within the front building area and affords observation from the lobby. The single large window between these spaces is of the "invisible" type, the surfaces being curves of continuously changing radius designed so that all external reflections are directed away from the observer and to an absorbing surface. Behind the Master Control Room is the Main Equipment Room in which the bulk of the amplifier and relay switching equipment is installed. The area in this section also includes the transcription studio, announce booths, reference recording room, field pickup, equipment storage and shop facilities, and the technical staff rest



Audio facilities for three studios, typical of standard NBC practice

room, thus concentrating technical plant operations.

The section of the building directly across the main corridor from the technical operation area contains the principle program and traffic operating offices. This includes the program management, the traffic office, announcers' offices, arrangers, music rights, press, production, continuity writing, the music library, sound effects workshop and storage, and the principal storage space for studio paraphernalia.

Floating wall type of soundproofing is used only in the organ studio. The mass of, and spacing between, the masonry studio enclosures was designed to give the necessary sound isolation between the studios and external spaces. All other masonry bearing on or against studio walls is insulated therefrom by cork. Standard NBC practice and design formulas were followed to control reverberation within studios; rockwool behind perforated compensation board and V-shaped hard plaster surfaces were used to get the desired effects.

Electrical power service to this plant consists of two separate high tension primary feeders with automatic changeover facilities. One feeder carries Boulder Dam power, the other is energized from the municipal steam generating plant. For extreme emergencies a third source of power is provided by a 25 kw a-c gasoline driven generator. This connects with the principal broadcast equipment power supply buss and, through separate circuits, with high intensity light fixtures in the studios, thus assuring program service in case of major disasters. Loss of interconnecting telephone lines between the studios and the radio transmitters and networks in such an emergency would be replaced by use of various portable relay radio transmitters and receivers, normally used for field work.

All studios and operating offices (essentially the first floor area) are air conditioned, the fans, compressors, pumps, and condensers comprising this installation being located in the basement. The system has a normal refrigerating capacity of 120 tons, somewhat less than peak load requirements, carry-over capacity being provided by an 85,000 gallon cold water storage tank underneath the building. The climatic conditions determining the heat load during a daily period in Hollywood are such that considerable economy in first cost and in operation thereafter, is possible with a storage tank arrangement.

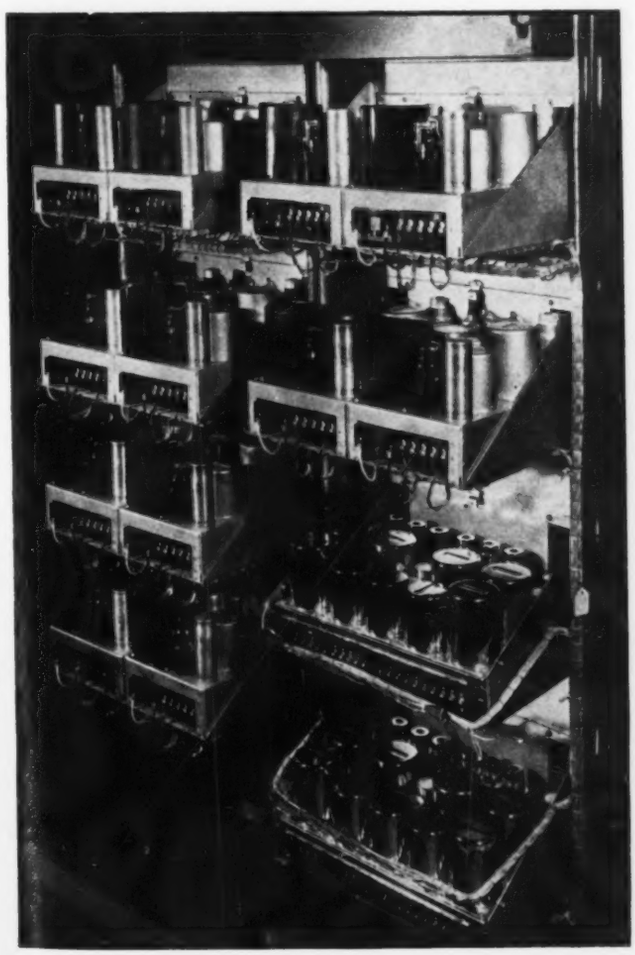
All studios have individual volume temperature and humidity control; office spaces are grouped in zones. Supply air, and some of the return air from the conditioned spaces, is carried in metal ducts, but in the audience studios return air is admitted through the vertical stage facures and conducted through concrete duct ways, to the return fan. These duct ways with their sound control labyrinths may be observed on the basement plan sketch. To prevent noise caused by air rush, air velocities are definitely limited and entrance and exit grilles are designed to provent excessive turbulence. The fundamental broadcast transmission circuit scheme is shown in the accompanying diagram which, incidentally, is the standard system used throughout the various division plants of the National Broadcasting Company. The physical equipment in the chain begins with the studio microphones of which an ample sup-

ply is made available in each studio. Three types of microphones are normal equipment; the straight velocity ribbon type, the uni-directional ribbon type, and a pressure type especially for announce purposes. Receptacles into which the microphone may be plugged are installed near the base of each of the four walls of the studios. In the auditorium studios, flush type stage floor pockets are used, in addition.

All microphone outlet circuits terminate in a jack field at the control booth console below which are the drop cord jacks which connect with pre-amplifier inputs. Thus any of the numerous mike outlet receptacles may be connected into the mixer, the latter being designed for an eight-position program microphone input, with an additional input for the announce microphone. The mixer circuit is shown, the announce microphone fader being connected therein in such a manner that anouncements over background music can be conveniently effected, the entire group of eight program faders being controlled by a master program attenuator. The main gain control, of course, is located at the final point in the mixer output circuit, and in normal operating practice is used for a preliminary overall level gain setting for a particular type of program, the instantaneous adjustment thereafter being obtained by manipulation of the Master Program and Announce microphone attenuators.

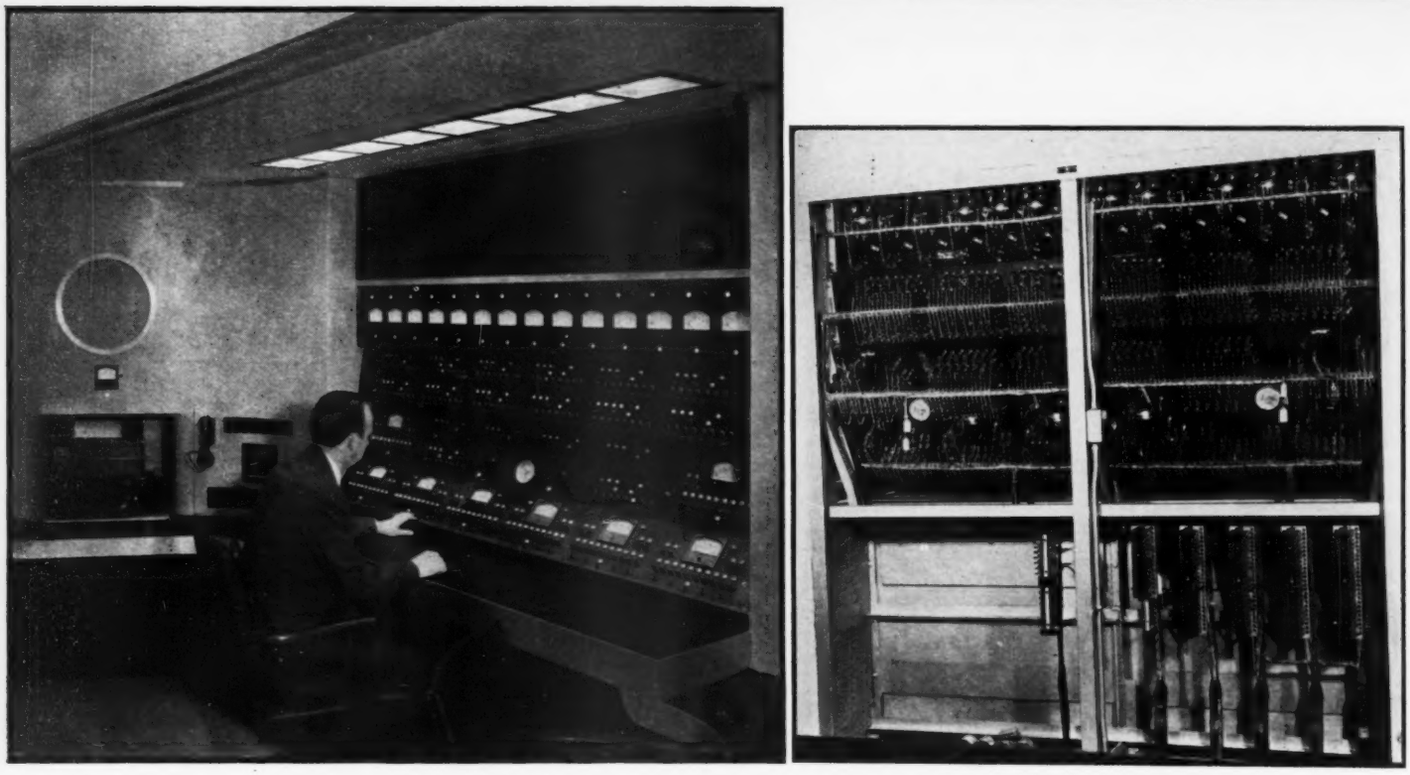
The booth control console main panel presided over by the studio engineer, is of interest. The eight program microphone fader knobs appear in the central portion together with the announce and master program fader knobs. The latter are smaller, and the faders are designed to be especially smooth operating for thumb and first finger control, since they are in use continually during a program. The principal signal light, the so-called "Carrier" signal also appears in this portion of the panel and is used to indicate that the outgoing transmission circuits are in readiness and the program can be started. Other signal lights indicate whether announce or program microphones are being used or whether the program is being received from a point outside the studios. Accessory controls on the console panel include a fader by means of which acoustical delay of "echo" effects may be introduced, and also faders for volume control of booth, studio, and studio sound re-inforcement loudspeakers. The announcers' controls in the studio are duplicated at the main console and a clock, volume indicator, and controls for illuminated studio door entrance warning signs complete the panel equipment. The key beneath the duplicate Carrier light at the right hand is operated at the close of a program and sets in motion the automatic channel transfer equipment which will be described later.

Since color has been made a feature of the Hollywood plant decorative scheme, the control booths follow in this regard. The consoles themselves are finished in a blue-gray neutral lacquer, the panel inserts being a light umber matte surface. Colors and surfaces have been chosen to avoid undue contrast in brightness between units and between units and surroundings, a considerable factor in eye comfort of operating personnel. For the same reason the glass



Left, the amplifier- and power-supply racks are lessons in neatness combined with accessibility

Below, the lobby showing mural and observation window of master control room



Front and back of the master control panel, where each outgoing channel is monitored

observation panels have been tilted forward to eliminate visible reflections of lights and bright surfaces from the view of the operating and program production personnel and engineers.

The studio control booth consoles are designed in the form of a right angle to fit the far corners of the control booths thus effectively preventing through traffic interference with the engineer by providing "dead end" isolation. With this design right and left hand models were required, depending on which side of the observation windows the booth entrance door is located. A built-in table which sets against the observation window and adjoins the control console is available for use of the program production staff. The latter staff is also provided with a means of addressing rehearsals within the studio by means of a microphone and loudspeaker.

Within the studio the announcers' controls are contained in a small desk which is secured to the wall nearby and within sight of the control booth. At this desk, by means of push buttons, the program and announce microphones, outside pickups, and the local and network groups of outgoing transmission lines may be connected to the studio output by remote control. In addition, the chimes cues for the network are operated from this point. Headphone monitoring of selected outgoing and incoming program channels is available at a jack strip in the face of the announcer's desk, so that he may listen in for cues or other reasons on other programs leaving or passing through the Main Control Room transmission circuits.

All mixer output circuits are routed in conduit and cable to the Main Equipment Room where they connect to the input of the standard studio amplifiers which provide an output power of 1.25 volts across a 125 ohm resistance termination. At this point the various channel and monitoring amplifiers, all having a high impedance input, are connected in multiple through the agency of the program switching system. The outputs of the channel amplifiers connect to the outgoing telephone transmission lines through a resistance network having an attenuation of 6 db and providing sufficient isolation to prevent appreciable operating error in reading line input levels at this point.

The standard NBC program switching system of the switchbank-selector type is an interesting feature of the Hollywood plant. This system was first developed for Radio City, New York, and has since been installed throughout the NBC divisions. It combines flexibility of function with any desired degree of automatic control and is arranged to operate on a pre-set basis which eliminates much confusion at the instant of switching, when several circuit changes must be effected at the same time. This is normal NBC routine since several networks are ordinarily in service.

To explain the operation of this system it is necessary to refer to the elementary grid-type relay distributing systems which were in early use. In this system, relays are inserted at all the junction points, each group of relays being interlocked in a vertical line, to prevent connecting together two or more of the input busses. In such an arrangement, a master control function becomes impractical for a large number of channels and input busses, as each relay control must be separately accounted for. In addition, at each switching operation all the channel relays must be released and connected to another input, even though the same channel group is being used. Besides the foregoing, the functions of pre-selection and automatic operation become quite involved in such a system for the same considerations given in first point above.

The problem of a more elaborate system was solved by reversing the approach. Since the source of a program connecting to any number of outgoing channels is always a single channel, grouping the relays associated with outgoing channels in so-called switchbanks, and arranging for a single connecting means between them and any single program input, simplifies the problem. Many separate channels may be taking programs from a studio plant, and there

(*Continued on page* 73)

Frequency Drift Compensation

By means of a silver-plated-ceramic negative-temperature-coefficient condenser, with a 27-ohm resistor to keep it warm, drift in a superheterodyne may be reduced to low values

By M. L. LEVY

Radio Development Laboratory
Stromberg-Carlson Tel. Mfg. Co.

FREQUENCY drift in oscillators in a radio receiver is a problem which has been confronted since the advent of the superheterodyne. The problem has been attacked and partially solved in any number of ways. The particular problem to be discussed here is to so compensate for frequency drift with temperature as to make the drift unnoticeable by the user throughout any period of operation. That is, the consumer should never be conscious of a "detuning effect" or poor quality due to the receiver drifting from resonance.

About 6 years ago the writer developed a compensator used in a small tuner (with preselected stations) which was composed of a bi-metal strip which reduced the capacitance of the oscillator circuit with rising temperature and obtained its heat for operation from a tube nearby. This was found to have been very successful since the tuner box was entirely enclosed, and within very narrow limits the compensator repeated its operation both in the laboratory and in the field. This same principle was applied to the usual type of chassis and the results were not nearly as uniform either in the laboratory or in the field. This led to the conclusion that in order to make this type of compensator operate uniformly and repeat its results satisfactorily, the applied temperature must be controlled within very narrow limits. The figures show the circuit and the unit used in the old type of tuner.

The bi-metal plate was formed as shown and the assembly was so arranged to provide low minimum capacity (5 $\mu\mu f$). The change in capacitance from cold to hot was about 0.10 $\mu\mu f$ which caused the drift curve to vary never more than 500 cycles from resonance.

With the advent of the push button trimmer type tuning, the problem again arose of reducing drift in the oscillator where automatic frequency control was not desired. The same method as was used in the tuner again suggested itself but after careful investigation in which the chassis employed was of the conventional type our results were not as uniform as desired. Further, the addition of excessive minimum capacitance was not possible to enable the proper compensation.

The problem was then attacked as follows: The drift was measured without any push buttons connected in the circuit. The purpose of these measurements was to determine the repeated drift of the receiver less push button trimmers. The drift was then measured to determine the contribution to the total drift of every component used. The circuit of Fig. 3 shows the test set-up for measuring drift.

The receiver is tuned to the 3rd harmonic of the 455 kc crystal (1365 kc) with the oscillator operating at 1820 kc since the receiver intermediate frequencies is at 455 kc. The beat note in the loudspeaker is the result of 1365 kc signal from the crystal which is always constant beating with the 1820 kc of the oscillator which is drifting giving 455 kc to produce an audio beat note in the loudspeaker with the crystal fundamental. This audio beat note is then beat with the outputs of beat frequency audio oscillator in the receiver speaker to accurately determine the amount of drift in cycles.

Discussion of Measurements

The receiver used in the following measurements was a 7-tube, 2-gang single tube output receiver with push

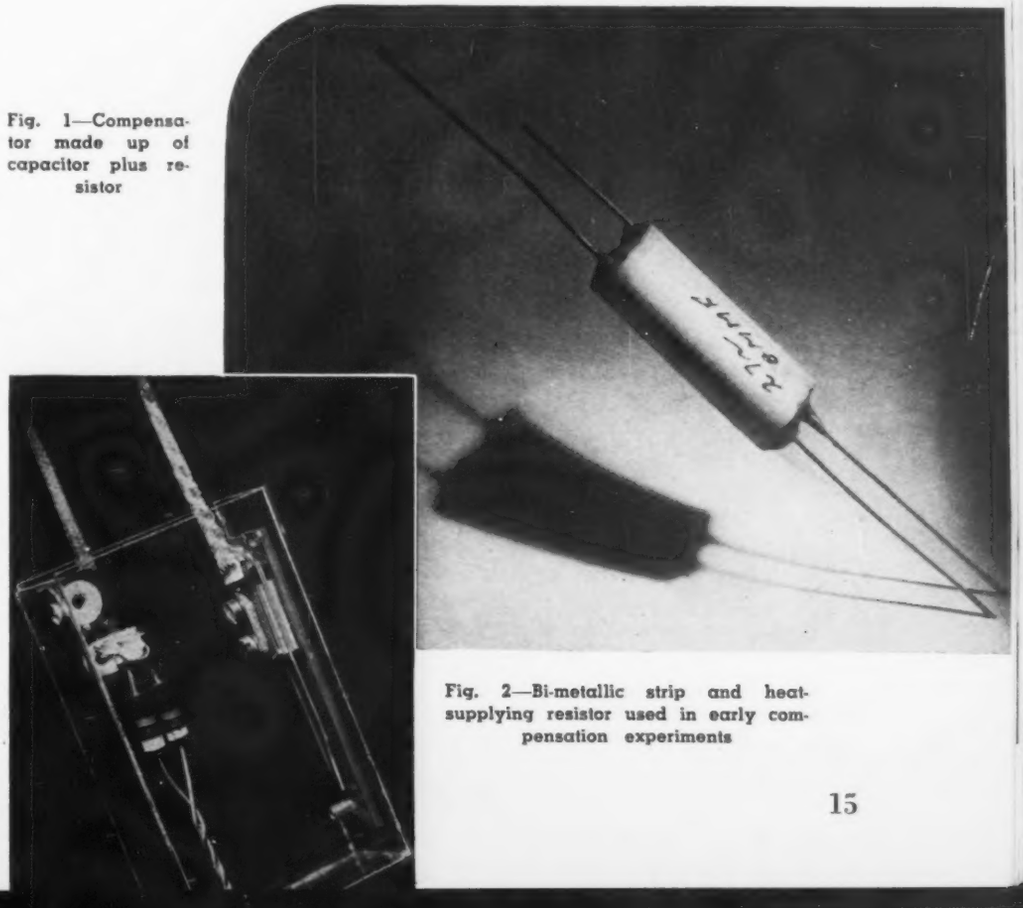


Fig. 1—Compensator made up of capacitor plus resistor

Fig. 2—Bi-metallic strip and heat-supplying resistor used in early compensation experiments

buttons, broadcast and short wave bands, with the 6A8 tube as the oscillator modulator. The total drift of a normal receiver was measured (shown on Fig. 4, Curve 1). This shows a drift from resonance to a lower frequency of about 2650 cycles.

The shunt pad was then removed adding more variable capacitance to tune the same frequency. This condition was found to have more drift, (Curve 2) approximately 4350 cycles. The obvious reason for this is that the trimmer used reduced its capacitance slightly with increasing temperature. This trimmer was investigated by itself and its negative drift characteristic was proved on a number of units and later verified by the manufacturer.

The shunt trimmer was again placed in the circuit and a fixed silver plated mica capacitor was used instead of the variable series padder. Curve 3 shows the result of this substitution, viz. that the drift from Curve 1 to Curve 3 is appreciably reduced, and under the condition of the shunt padder and a fixed silver plated series padder the drift is now only 1850 cycles. From this point on a fixed 300 $\mu\mu f$ fixed silver plated mica capacitor shunted by a 100 $\mu\mu f$ variable was used with results very nearly Curve 3.

The next step was to remove the range switch from the circuit and repeat the drift measurements. The range switch showed no appreciable contribution to drift.

The capacitance between primary and secondary windings of the oscillator coil was suspected of contributing to the drift. The primary was wound directly over the secondary at the low side with .015 inch varnished paper insulation in all previous measurements. To check this effect a primary coil was inserted inside the secondary coil form giving as near as possible the same oscillator performance but providing air dielectric instead of varnished paper. The results on this oscillator coil measured the same as previously, showing that the particular oscillator construction used did not contribute to drift appreciably or at least the substitution of air dielectric is no better at the given temperature rise.

To further check the oscillator coil drift characteristics a ceramic coil form was substituted for the bakelite coil form used previously. Here again no substantial change in drift could be measured. The probable reason for this is that the temperature rise in and around the oscillator coil form did not affect the formica coil form sufficiently to change it appreciably. (In previous tests when the temperature rise was much greater than in this particular set, ceramic proved substantially superior.)

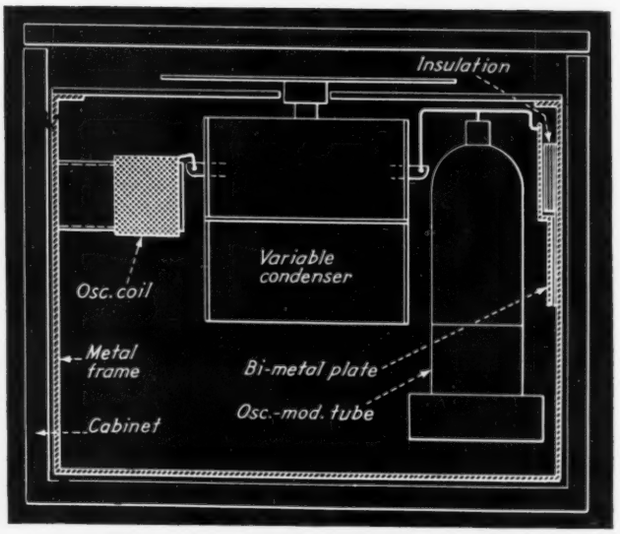


Fig. 3 — Above, previous method of compensating drift. Below, set-up for measuring drift

With Curve 3 representing the best compromise for the particular receiver in question for manual operation and no compensation, a push button unit of the capacitor tuned type was added to the chassis. This was switched into the circuit by means of the standard range switch which at the same time removed the gang condenser from the circuit. Curve 4 shows the drift measurement of the receiver with the push button unit added. It is noted that an increase in drift is measured from Curve 3, from approximately 1850 cycles to 2800 cycles. (This value varied somewhat with various units but the average is indicated by this measurement). At the same time the push button unit was added a shunt coil was necessary to reduce the inductance to compensate for the added minimum capacitance of the push button unit. The shunt coils reduced the total drift of the circuit very slightly.

Compensation was then added to reduce the drift to a value where it would never be more than 500 cycles off resonance. Any fixed commercial unit of the negative drift type required a value so high with the temperature rise of the receiver as to render it useless because of the reduction in tuning range using the same coils as used to tune the receiver under manual conditions. The procedure then was to use the maximum allowable shunt capacitance to obtain the desired range, which resulted in 8 $\mu\mu f$ and apply added heat by means of a resistor unit close by to produce the proper change to effect the necessary compensation.

A number of commercial units was tested in this manner. The first experiments were conducted by winding resistance wire on the outside of the standard compensator units and shunted across the heater winding to produce the power necessary. Liquid compensator, bi-metal units with a heater unit enclosed in a small can, and the fixed silver plated units with negative drift characteristics were used to obtain desired results.

The unit finally adopted had the

silver plated ceramic unit of the negative drift type (shown in Fig. 1) housed with a resistor unit. The resistor unit is 27-ω and the cold capacitance value 8 $\mu\mu f$. The 27-ω resistor is connected across the 6.3 volt heater winding and the 8 $\mu\mu f$ is connected across the high side of the oscillator grid circuit.

Curve 5 shows the result of adding the 27-ω, 8 $\mu\mu f$ compensator unit to the receiver with 6.55 volts across the 27-ω. It is noted Curve 4 is the drift curve with no compensation. Curve 5 shows drift in the first few minutes in the opposite direction to the normal curves, at about 20 minutes it passes through zero and drifts in the same direction as Curve 4 but only attains about 450 cycles maximum at the end of 90 minutes. (These curves were carried out to 3 hours with no substantial change). Curve 6 shows more power used, here a 22-ω (6.55-v) resistor and 8 $\mu\mu f$ capacitor is used. It will be noted that even more reduction in drift is obtainable.

Thus the development of this "thermal compensator" unit provides a characteristic drift curve for the receiver which, for the first 10 or 15 minutes of operation, is opposite to the normal drift. In doing this it reduces the rate of drift of the receiver while the components are heating up. Curve 4 shows a drift of 1900 cycles in the first 15 minutes and Curve 5 shows 450 cycles in the first 3 minutes and at 15 minutes it is nearly zero beat. Thus for push button operation especially, regardless of at what point in time the station is "set up", the drift from resonance can never be more than ±500 cycles from resonance, which is very desirable for successful fixed tuning. Various production receivers checked from time to time show slight variations for the above values in that the push button units vary somewhat. In any event the characteristic of the compensating unit provides for a reduction of the rate of drift in the first few minutes effectively and since it caused the drift to be in the opposite direction to the normal drift of the receiver, variations of the drift of the push button unit will cause the curve to go more negative or more positive within limits. If a push button unit has more drift than normal, the resulting curve may be all in one direction of resonance although the characteristic shape of the overall curve (Curve 5) will be maintained.

The characteristic of the compensator by itself is represented by Fig. 4 with time vs. $\mu\mu f$ indicating that the compensating action endures approximately from 6 to 8 minutes, and that the change in capacitance is very rapid for the first few minutes. This effect at the very start overcompensates for the heating up of the oscillator tube which is responsible for 800 to 1000 cycle drifts in the first few minutes. The remainder of the components then drift only in the direction to overcome the excessive drift of the compensator unit, thus tending to return the circuit to resonance.

The conclusions to be drawn from this development are that the thermal addition to the fixed temperature variable compensator can be controlled by many factors. It is possible to use a value of 8 $\mu\mu f$ to produce effects normally obtained with much larger units by applying external heat. If the temperature rise of the receiver had to be used to operate the compensator, a value of about 70 $\mu\mu f$ would be necessary. It is also possible by means of two different characteristic compensators, such as one which drifts positive and one which drifts negative, to obtain any desired shape or slope and with the proper insulation to develop time characteristics as well.

This same principle of thermal addition was applied successfully to motor drive push button receivers, where the proper compensation limited drift to ±500 cycles.

Figure 2 shows the first experimental unit developed using a bi-metal spring and resistor to provide the necessary heat. The development from this point on is described throughout this article.

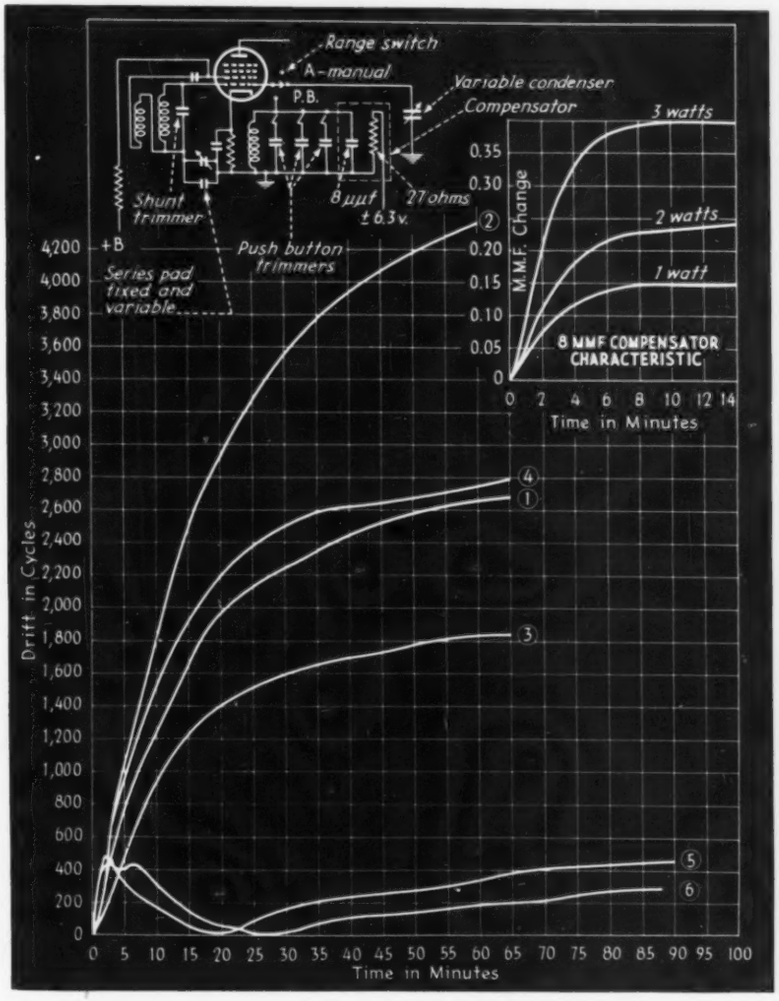
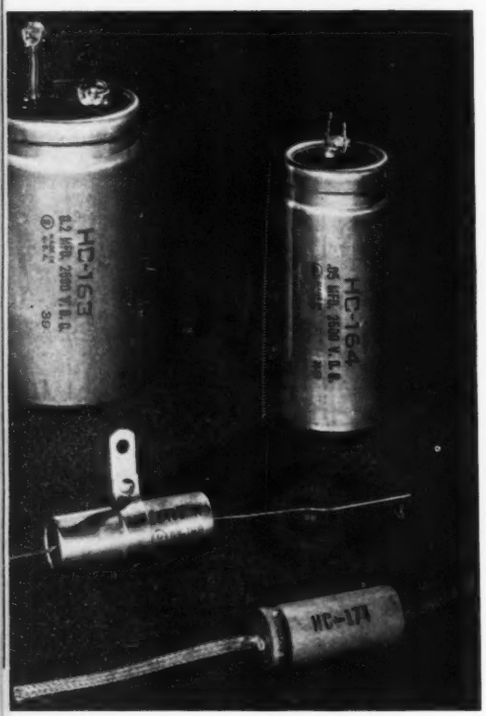


Fig. 4—Circuit and results of measuring drift contributed by various components

Television Components



Filter and coupling capacitors designed for television by Sprague engineers

WITHIN two months the number of radio set manufacturers who have announced their intention of producing television receivers or kits has nearly trebled. In March, *Electronics* reported six manufacturers in the field. At the present writing the list has grown to include the following names: American Television, Andrea, Crosley, DuMont, Emerson, Farnsworth, Garod, General Electric, Hallicrafters, Majestic, Meissner, Philco, Pilot, RCA Victor, Stewart-Warner, Stromberg-Carlson, and Westinghouse. This is an impressive list, but it by no means includes all the firms who have a stake in the television business. Behind the receiver manufacturers there are a large number of supply companies which have developed special components for television purposes. Many of these components differ materially from those used in sound receiver production, not only because of the new functions involved, also because the standards of quality and stability must necessarily be higher for video work.

In the interest of investigating the television components business, *Electronics* requested information from 147 parts manufacturers in the radio and allied fields. This report reviews replies received from some 25 firms.

Analysis of the returns from components manufacturers shows that nearly every type of part is being made in specialized form for television receiver production. The list includes tubes (cathode ray tubes as well as pentode amplifiers and rectifiers), capacitors (tuning, by-pass, coupling and filter types), resistors (variable and fixed, especially for high voltage work), and inductors (r-f, i-f, and video coils, scanning and power supply transformers) as well as a large number of special mounting parts, sockets and cathode-ray tube accessories. Three manufacturers (Andrea, Garod, and Meissner) are producing complete kits of parts from which television receivers may be assembled with a minimum of technical knowledge. Several firms have announced dipole antenna structures for television reception. While many receiver manufacturers are producing their own parts, there is at least one source of supply, generally available to the trade, for every component which goes into a television receiver.

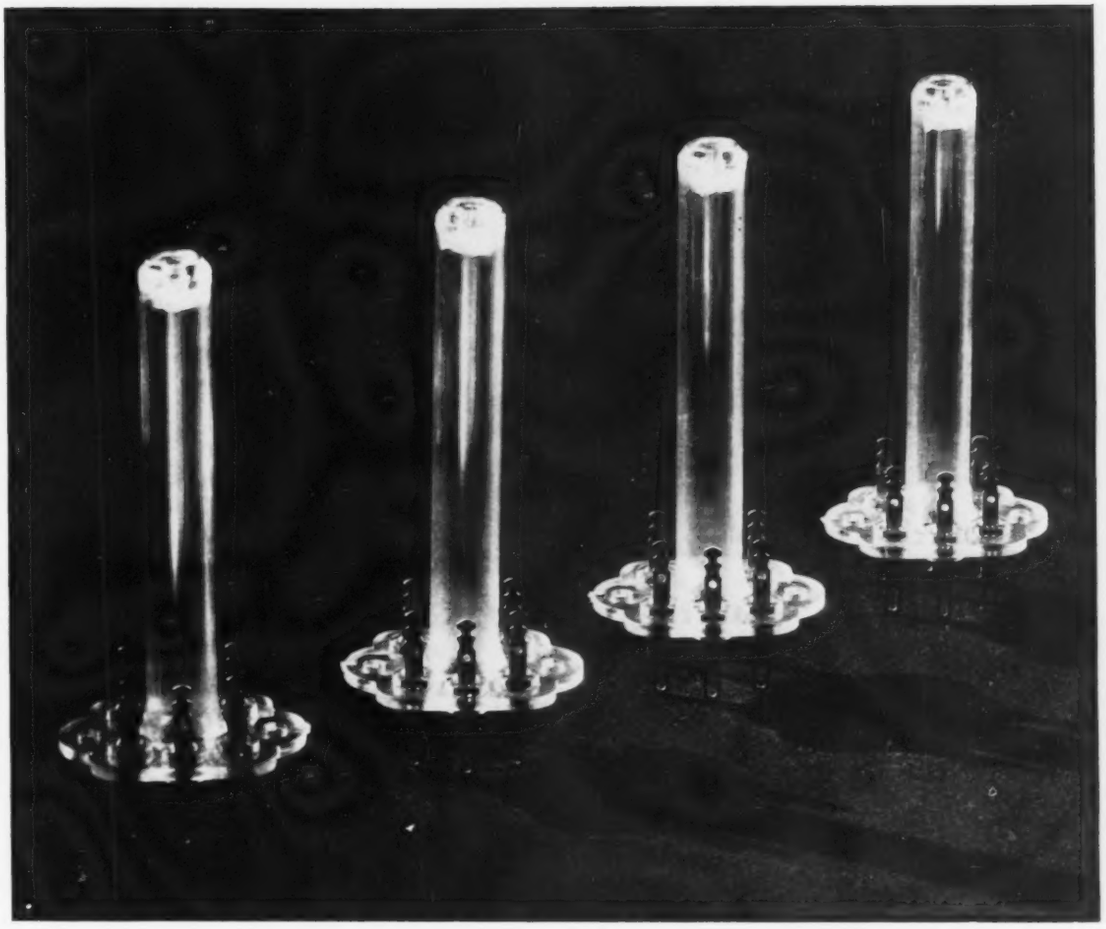
The following descriptions of television components are classed according to their function in the receiver. Every attempt has been made to include all suppliers, but it has been necessary to restrict attention to those parts which have been specially developed for television purposes, and to exclude those parts which, while used in television receivers, are not essentially different from those employed in conventional all-wave sound receivers.

Two specialized volume controls, a low-capacitance unit by IRC (left) and a center-tapped centering control developed by Mallory-Yaxley

Cathode-Ray Tubes and Power Supply Components

Table I (page 60) shows the cathode-ray tubes now available, together with the more important operating characteristics. The sources of supply include four companies: The Allen B. DuMont Laboratories, Hygrade-Sylvania Corp., National Union Radio Corp., and the RCA Manufacturing Company.

The cathode-ray tube power-supply auxiliaries include high voltage and filament-heating transformers, high voltage bleeder resistors, insulated shaft volume controls for focussing, filter capacitors, insulated sockets,



Video i-f coil forms, molded from Bakelite polystyrene by the Erie Resistor Corporation, for use in RCA receivers

and high-voltage fittings and interlocks.

High voltage transformers are available on special order from nearly all transformer manufacturers. Stock transformers carried by RCA (Camden) include a 7000-volt (d-c output) power transformer, including rectifier filament winding (stock number 9861). An RCA transformer (stock number 33390) for 5-inch tubes includes 2200-volt high voltage and windings for all receiver functions, (low voltage plate supply, 6.3 volt heater windings, 5-volt rectifier heater and 2.5-volt heater). The Halldorson line includes a transformer (type S-100) for a 5-inch tube, with 1500 volt (r-m-s) winding at 10 ma, and two 2.5-volt heater windings. Kenyon transformers include a 3000-volt model (type T-203A) for 5-inch tubes and a 1200 volt model (type T-208) for 3-inch tubes. Both these transformers include heater windings. The Kenyon type T-204A is a 6000-volt unit for 9- and 12-inch tubes, with three 2.5-volt windings. The United Transformer Company makes two transformers: type PA-321 for 4500-volt (r-m-s) with two 2.5 volt windings and type PA-322 with 2300-volt secondary and heater windings.

The resistors and volume controls used in the high-voltage bleeder circuits are in most cases conventional. However two specialized forms of high-voltage fixed resistors have come to light. One is the metallized spiral type manufactured by International Resistance Co. Values of resistance as high as several thousand megohms at ratings up to 50 watts are available, with or without taps. Such resistors are also useful as multipliers for high voltage voltmeters. High resistances sealed in ceramic tubes useful for high voltage work are made by Ohio Carbon. The Erie Resistor Corp. has designed a "ring" form of carbon resistor which can be assembled in varying resistance values and power ratings, with taps at desired positions. The voltage rating of the larger resistor is 1000 volts per unit, which is considerably higher than the usual carbon resistor can stand. S. S. White Company has a line of very high resistances suitable for measurements, as well as circuit purposes.

The volume control manufacturers are supplying standard controls for focus and brightness controls, the only difference in the majority of units being an insulated shaft, from 2 to 3 inches in length, which permits using the control several thousand volts above chassis potential.

High voltage filter capacitors especially designed for cathode-ray power supplies are now offered by several firms. The General Electric Company has standard "Pyranol" oil-filled capacitors in ratings from 1500 to 7500 volts d-c working voltage, at capacitances up to 0.5 μf in the high voltage rating. The Cornell-Dubilier Company has a line of "Dykanol" units for working voltages from 1,000 to 10,000 volts, at values from 0.01 μf to 0.5 μf. RCA offers a 0.03 μf 7500 volt capacitor, stock number 33018, Aerovox makes the "Hyvol" line, with voltage ratings and capacitances suitable for all television power supply applications. The Solar Company line includes capacitors rated at from 1000 to 7500 d-c work-

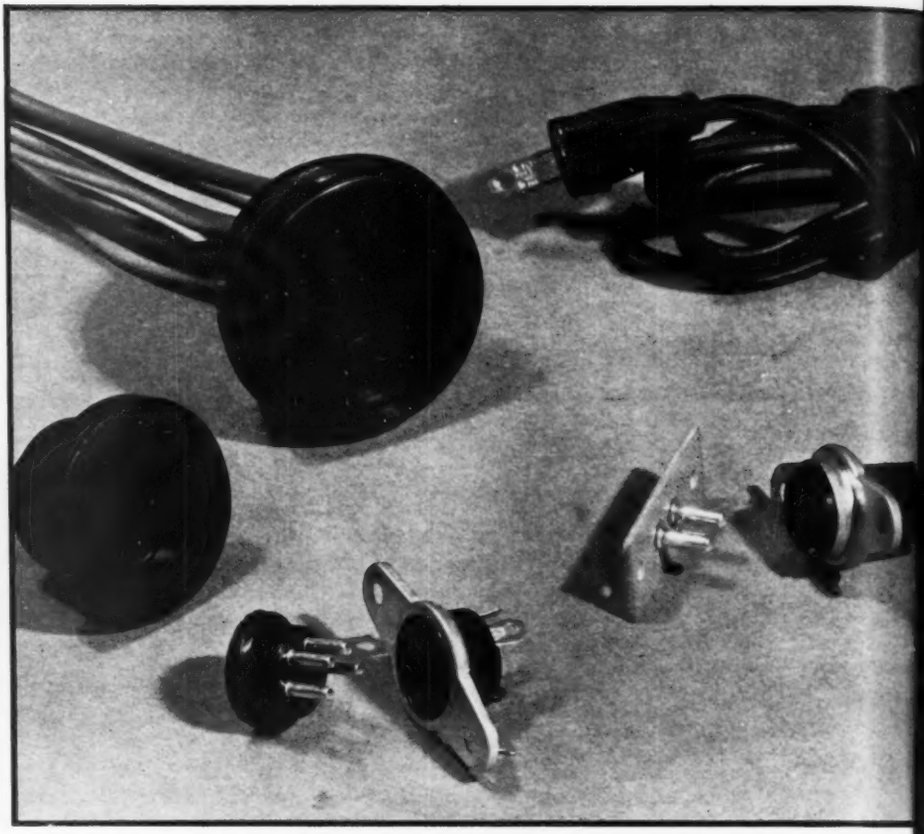
ing volts. In the lower voltage ratings, capacitances as high as 10 μf are available in a single unit. At the higher voltage ratings, however, the highest capacitance is 0.1 μf. In the usual filter circuit, at 5000 to 7000 volts, two units are used, each of about 0.05 μf capacitance.

Several high-inductance reactors for use in high-voltage filter circuits are available, although current practice seems to favor the resistive type of filter structure. Halldorson has two chokes intended for 5-inch tube power supplies. RCA manufactures a 1500-henry choke, as does the United Transformer Company. American Transformer Company has done a great deal of work with such reactors resulting in decreased corona.

Since most high voltage power supplies are of the grounded negative type, it is necessary to insulate the rectifier socket for the d-c output voltage. Several insulated sockets of this type are available. The Alden Products Co. has a molded Bakelite socket with two projecting arms which increase the insulation path from terminals to chassis by 2 inches relative to the conventional socket. This socket (type 484B) is intended for voltages not higher than 3000 volts, i.e. for 5-inch tubes. For higher voltages, socket type 494B of similar construction is available, for use with the 2V3G tube, with peak inverse voltage as high as 16,500 volts. The Ferranti Company offers an electrostatic high-voltage voltmeter.

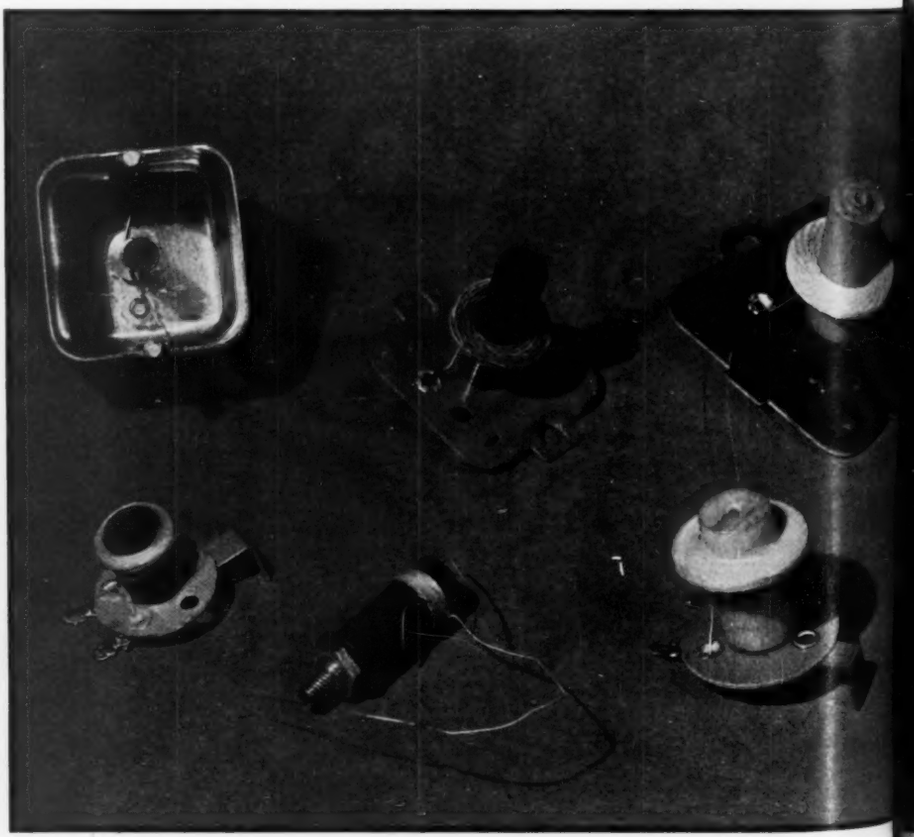
The rectifier tubes suitable for high voltage power supply work are shown in Table II. The type 2V3G seems to be an almost unanimous choice for 5000- to 7500-volt supplies, except where voltage doubling is employed. For the lower voltages the 879 and 2Y2 tubes are widely used. The 878 is not used because of its high cost, and the fact that it has only slightly superior performance relative to the 2V3G.

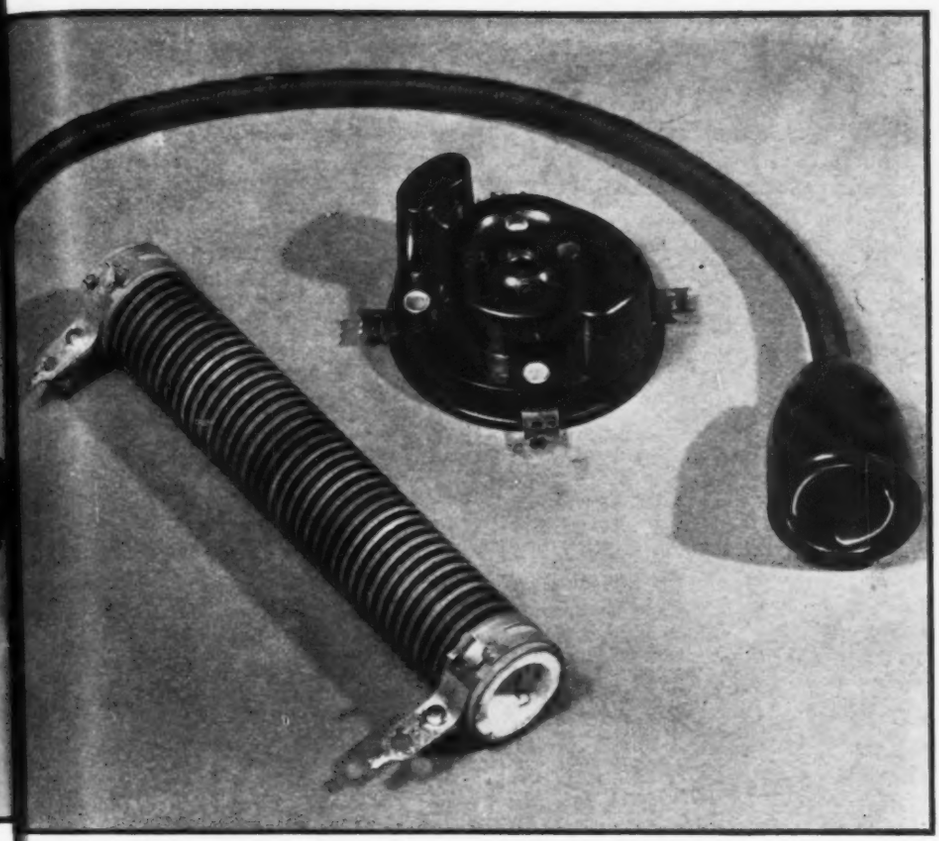
The Alden Company makes a wide variety of mounting parts and accessories for cathode-ray tubes, several of which are shown in the accompanying photographs. Several varieties of "magnal" 11-prong sockets for the 1802 and 1805 types of cathode-ray tube are manufactured by Alden. The sockets are equipped with color-coded leads having the proper insulation for the high voltages and having a grid lead separated from the



Sockets and plugs of the Alden Products Company. A six-prong cathode-ray tube socket, an 11-prong magnal socket with leads, 110-volt power supply interlock plug, and (foreground) plug connection for scanning generator leads

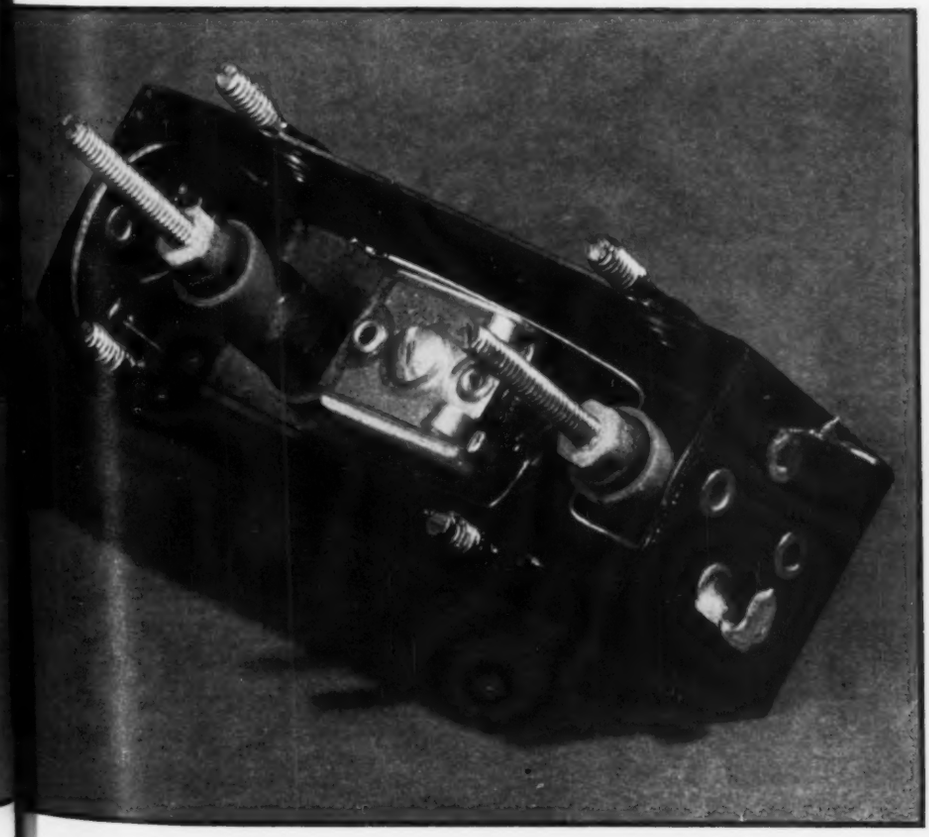
Meissner coils and tuned circuits. Above, can and coil of a 14.25-Mc trap, and (right) coil of a 13-Mc trap choke. Below, left to right, a video amplifier peaking coil, an 8-Mc sound channel grid coil, and a video second-detector coupling coil





Parts for high voltage: a metallized-spiral resistor (IRC) suitable for 25 watt service, an insulated rectifier-tube socket for high-voltage power supply (Alden) and a 7000-volt second anode connector with insulated shell and lead (Alden)

Picture intermediate transformer manufactured by the F. W. Sickles Company. It is designed for sub-panel mounting in conjunction with single-ended tubes, displays a useful bandwidth of 3.85 Mc with adequate attenuation of adjacent sound channels

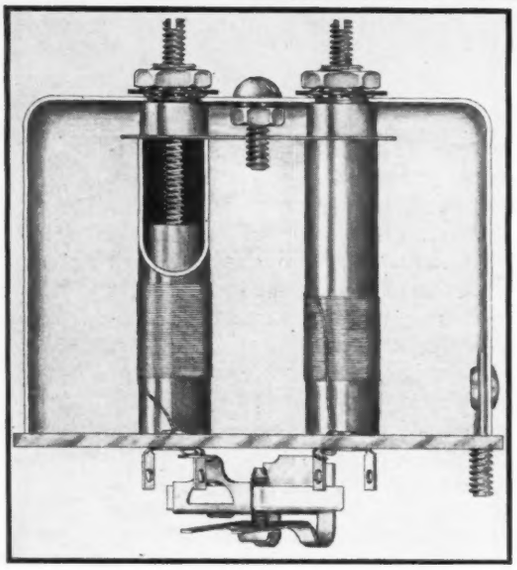


rest, to maintain low wiring capacitance. Six-prong sockets for 1800, 1803, and 1804 type tubes are also available from this company, fitted with lead wires. In one form, a high collar is molded around the socket to surround the base and give complete mechanical protection against the high voltage. The material of these sockets is corona-resistant, and is molded to preserve this property. For the grid leads, special low-capacitance connectors and plug-jack combinations are made. For the second anode connector, an Alden fitting is available which completely covers the cap and insulates it. A special protective grid cap for the type 879 rectifier tube is available which prevents the user from coming in contact with the high voltage supply even when he removes the cap with the voltage on. The American Phenolic Company also makes several types of sockets, grid caps, low-loss bushings, and cables for use with cathode-ray tubes.

An interesting form of interlock, made by Alden, is shown in the photograph. It consists of a standard cord and plug assembly with a two-prong recessed jack fitting. This fitting is fastened to the rear cover of the receiver. When the cover is in place, the jack engages a two-prong plug, mounted on the cabinet or chassis, and thereby applies the 110-volt power to the set. The cover cannot be removed without breaking this connection and removing the power from the set. The jack fitting, while connected to the 110-volt line, does not present any exposed contacts when disconnected from the plug, thereby avoiding the possibility of shock by contact with the fitting itself.

Scanning Generator Components

Components used in the scanning and deflection systems of television receivers are divided into two classes, those intended for magnetic deflection and those for electric deflection. The former are the more specialized, since for magnetic deflection a scanning yoke and special output transformers are required. The saw-tooth generators which are essentially the same in both forms seem to be principally of the blocking oscillator variety, and require special transformers. According to present advices, four manufacturers have equipment



The Meissner video i-f transformer, permeability-tuned

of this sort available: Kenyon Transformer, RCA (Camden), and United Transformer. Apparatus for use when short retrace time is desirable has been designed by Amertran.

The Kenyon line includes a magnetic deflecting yoke, type T-700A, which is considerably shorter than those heretofore produced and which is adaptable to deflecting the "short" 9-inch tubes. A magnetic focussing yoke, for cathode-ray tubes having magnetic-type electron guns, is available. Low and high frequency blocking-oscillator transformers are available (types T-60 and T-59 respectively), as well as low and high frequency output transformers for magnetic deflection (types T-111A and T-112A).

The RCA line includes type 9857 low impedance deflecting yoke (with low impedance vertical coils), type 32899 horizontal blocking oscillator transformer, type 9862 horizontal output transformer, and type 32900 vertical output transformer. These components are those shown in the diagram on page 24 of the March, 1939 issue of *Electronics*.

The United Transformer Company manufactures type PA-320 magnetic deflecting yoke, types PA-324 and PA-325 vertical and horizontal blocking oscillation transformers, and types PA-323 and PA-326 vertical and horizontal output transformers.

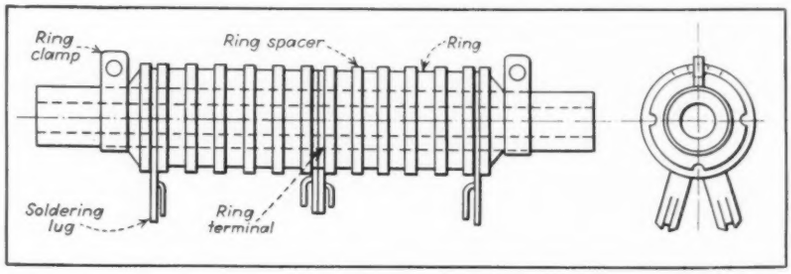
R-f, i-f, and video-frequency components

The signal circuits of television receivers demand highly refined design to accommodate the wide band of frequencies in the picture channel. The problem is answered in different ways at different frequencies, but in general it is desirable to keep the capacitance of each circuit at a minimum. Inductive tuning has therefore become the rule in most r-f and i-f circuits. The inductance is changed by varying the position of a powdered-iron core within the coil structure.

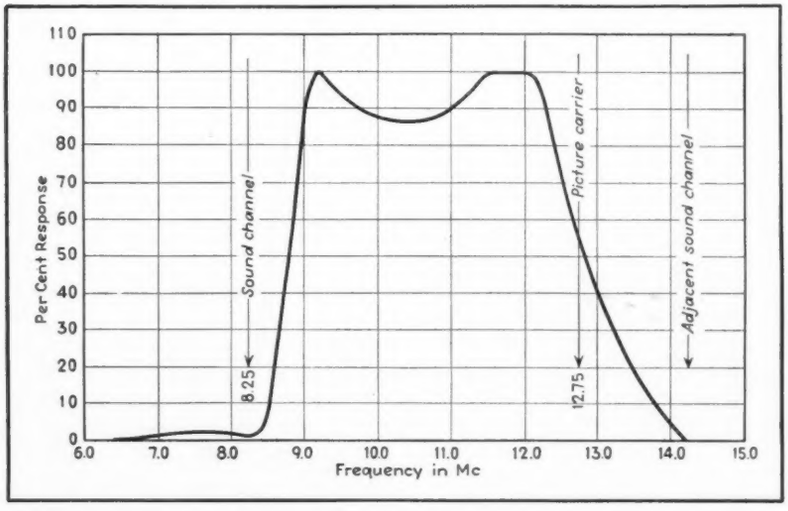
In the radio frequency circuits, very few complete components have been made available, except as adjuncts to complete kits. RCA makes a special plunger-type variable capacitor suitable for trimming purposes. Of interest in circuits which use lumped capacitance are the tubular fixed ceramic capacitors offered by Centralab, Erie Resistor, and American Lava Corp. These capacitors have very stable characteristics and can be made self-compensating against temperature variations. One use of such capacitors is in loading the tuned circuit of the u-h-f oscillator for the low-frequency channels.

I-f transformers, available from the Meissner Company and from the F. W. Sickles Company, are illustrated in the accompanying diagrams. Both units are of the permeability tuned variety, with capacity elements for coupling and signal rejection.

The Sickles transformers are intended for sub-panel mounting, to allow the shortest possible leads to single-ended tubes. Six transformers in all are used, four for the picture intermediate frequency system and two for the sound. The picture band-width is approximately 3.85 Mc. with a gain of 3500 using two 1853 tubes and one 1852. By employing 1852 tubes throughout the gain may be increased to roughly 6000. The sound channel displays a gain of about 4000 in two 1853 tubes. Included in the units are capacity-tuned wave traps for attenuating the adjacent channel audio signal and the



Erie Resistor's ring-type unit for high-voltage bleeders



Band-pass response of the Sickles picture i-f system, displaying a gain of 4000 in 3 tubes

associated sound channel.

The Meissner line includes a number of specialized coils, some of which are shown in the illustrations. Among them are a 41 μh peaking coil for use with a 2000-ohm plate load resistor in video amplifier circuits, low pass filter coils for connecting the picture detector to the video stage, and a sound i-f grid coil (8.25 Mc). Also available are trap circuits, one to remove the 12.75 Mc picture i-f from the sync circuits, and another tuned to 14.25 Mc to remove the sound i-f of the adjacent channel.

(*Continued on page* 60)

CIRCLE DIAGRAMS FOR TUBE CIRCUITS

Circle diagrams, which have long been used to predict performance of induction and synchronous motors, are here applied to determine the operation of tube circuits

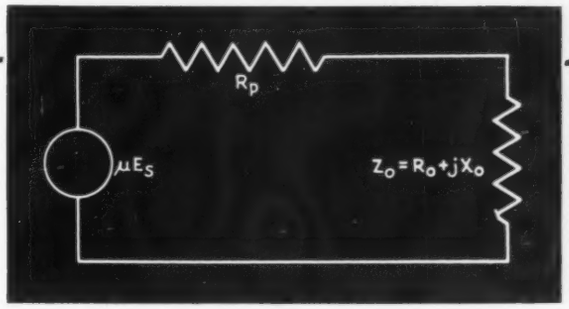


Fig. 1—Equivalent series circuit for tube and its load, the basis of circle diagrams

By A. A. NIMS
Newark College of Engineering

CIRCLE diagrams for induction motors are well known. Circle diagrams have also proved useful for synchronous motors, transmission lines, and even comparatively simple series and parallel circuits. Circle diagrams can be equally useful in the study of tube circuits; moreover, they can be set up in sufficiently general form to apply to any triode element, regardless of its constants.

The equivalent series circuit for the tube and its load, Fig. 1, is the basis of the circle diagrams. The amplification factor, μ, of the tube, and its internal plate resistance to alternating current, R_p, are the important constants. The external series impedance, $Z_o = R_o \pm jX_o$, is the equivalent impedance of the plate circuit network, whatever its complexity.

The values of R_o and X_o will, in general, change with the frequency, so that it is necessary to refigure them for each frequency at which the performance of the circuit is to be investigated. For the reduction of a network to an equivalent impedance, the circle diagrams give little aid. Their value lies in the extent of the performance data they reveal, once the equivalent series impedance has been computed.

The generality of the diagrams is brought about by using the relative values of external resistance and reactance, with R_p as a reference, instead of the ohmic values. These relative values are represented by k_r and k_x respectively. Thus, $R_o = k_r R_p$, and $X_o = k_x R_p$.

Circle Diagrams for Voltage Gain

The simplest circle diagram is that for constant voltage gain, or ratio of external impedance drop to signal input. The alternating component of tube plate current due to an alternating signal voltage on the grid, E_s, is well known to be, in effective values,

$$I_1 = \frac{\mu E_s}{R_p + Z_o} = \frac{\mu E_s}{\sqrt{(R_p + R_o)^2 + X_o^2}} = \frac{\mu E_s}{R_p\sqrt{(1 + k_r)^2 + k_x^2}}$$

Then the voltage gain is

$$V.G. = \frac{I_1 Z_o}{E_s} = \frac{\mu E_s R_p \sqrt{k_r^2 + k_x^2}}{E_s R_p \sqrt{(1 + k_r)^2 + k_x^2}} = \frac{\sqrt{k_r^2 + k_x^2}}{\sqrt{(1 + k_r)^2 + k_x^2}}\,\mu = k_v \mu,$$

where

$$k_v = \frac{\sqrt{k_r^2 + k_x^2}}{\sqrt{(1 + k_r)^2 + k_x^2}} \qquad (1)$$

This ratio is also independent of the tube, and expresses the voltage gain as a fraction of the amplification factor of the tube.

To get the equation of the circle diagram, square equation (1), clear of fractions, combine terms, and divide to make the coefficients of k_r^2 and k_x^2 unity, giving

$$k_r^2 + k_x^2 - \frac{2k_v^2}{1 - k_v^2} k_r - \frac{k_v^2}{1 - k_v^2} = 0 \qquad (2)$$

If k_r is assigned to the X axis, and k_x to the Y axis, it is seen that equation (2) represents a circle with its center on the k_r, or X axis. The points at which the circle cuts the X axis are determined by letting $k_x = 0$, and solving for k_r. This gives

$$k_r = \frac{k_v^2}{1 - k_v^2} \pm \frac{k_v}{1 - k_v^2} \qquad (3)$$

From this equation it is apparent that the abscissa of the center of the voltage gain circle is $\frac{k_v^2}{1 - k_v^2}$, and its radius is $\frac{k_v}{1 - k_v^2}$. With these data, it is a simple matter to construct circles for as many values of k_v, or relative voltage gain, as desired. Once these are drawn, any one of the three constants, k_v, k_r, or k_x, can readily be found, provided the other two are given.

Minimum Gain Locus

The highest point of each circle is directly over the center, and its coordinates are $k_r = \frac{k_v}{1 - k_v^2}$, and $k_x = \frac{k_v}{1 - k_v^2}$. Eliminating k_v between them gives.

$$k_x^2 = k_r^2 + k_r = k_r(1 + k_r) \qquad (4)$$

as the locus of the maximum points of the several voltage gain circles. The abscissa of each point on this

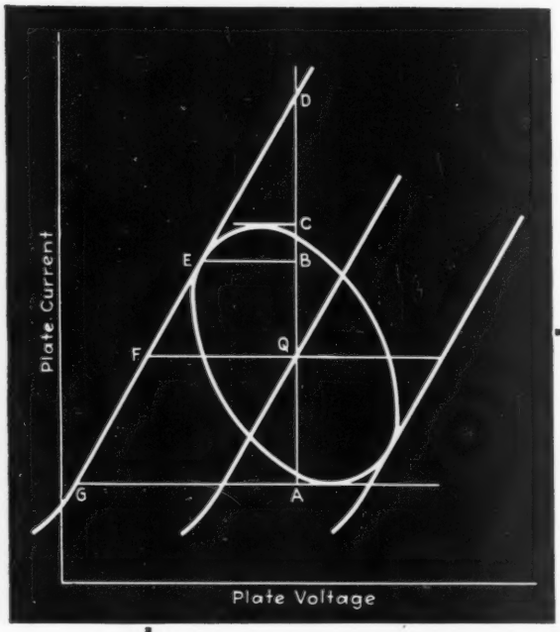


Fig. 2—For undistorted power output, the operating point of the tube is restricted to the area between lines GD and GA

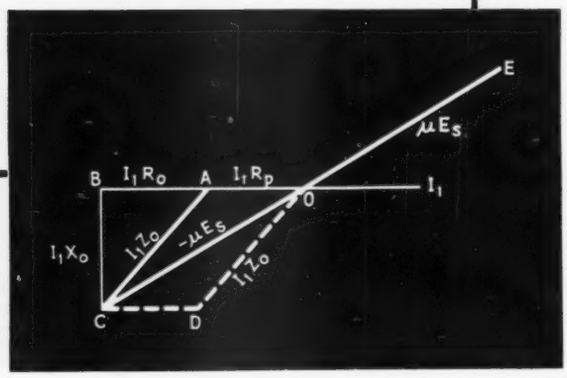


Fig. 3—Vector diagram for loaded triode. The phase difference of input and output is equal to angle EOD and has the same sign as angle COD

locus indicates the k_r value that gives minimum voltage gain when k_x is held constant at the corresponding ordinate value.

Circle Diagrams for Power Output

The next circle diagram is that for power output. From previous considerations, the power consumed in the external plate circuit, due to alternating current, is

$$P_o = I_1^2 R_o = \frac{\mu^2 E_g^2 k_r R_p}{R_p^2 (1 + k_r)^2 + k_x^2}$$

$$= \frac{\mu^2 E_g^2}{R_p} \frac{k_r}{(1 + k_r)^2 + k_x^2} = k_w \frac{\mu^2 E_g^2}{R_p},$$

where

$$k_w = \frac{k_r}{(1 + k_r)^2 + k_x^2} \qquad (5)$$

This ratio is also independent of the tube, and expresses the power output as a fraction of the power that would be lost in the tube if the external impedance could be reduced to zero. To get the equation of the circle, clear equation (5) of fractions, expand and rearrange to the following form:

$$k_r^2 + k_x^2 - \frac{1 - 2k_w}{k_w} k_r + 1 = 0 \qquad (6)$$

This equation also represents a circle with its center on the k_r, or X axis. Putting $k_x = 0$, and solving for k_r gives

$$k_r = \frac{1 - 2k_w}{2k_w} \pm \frac{\sqrt{1 - 4k_w}}{2k_w} \qquad (7)$$

From this equation it is evident that the abscissa of the center of the power circle is $k_r = \frac{1 - 2k_w}{2k_w}$, and its radius is $k_x = \frac{\sqrt{1 - 4k_w}}{2k_w}$. With these data, circles can be constructed for as many values of k_w as desired. When these are drawn, any one of the three constants, k_w, k_r or k_x, can readily be found, provided the other two are given.

Maximum Power Locus

Eliminating k_w between the expression for the abscissa of the center of the power circle, and the expression for its radius, gives

$$k_x^2 = k_r^2 - 1 \qquad (8)$$

as the locus of the maximum points of the several power circles. The abscissa of each point on this locus indicates the k_r value that gives maximum output when k_x is held constant at the corresponding ordinate value.

Maximum Undistorted Power Locus

The discussion so far has assumed linearity of the e_p, i_p characteristic of the tube, or constancy of R_p for all values of plate voltage and grid voltage. For many purposes this assumption is unwarranted, as the characteristic has a decided curvature, particularly at low values of plate current. One way of avoiding the resulting distortion is to keep the path of the operating point away from the curved part of the characteristic. This is done by specifying a minimum value to which the plate current is permitted to drop. Such a value of plate current would be represented by the line GA in Fig. 2.

Distortion of another kind results if the grid becomes positive with respect to the cathode, and draws current. This is prevented by not permitting the operating point to pass beyond the line GD, the e_p, i_p characteristic when the grid is maintained at the same potential as the cathode. The path of the operating point is then to be limited to the space between the lines GD and GA. Within these boundaries, this path may be so disposed that for a given grid swing the power is a maximum. The grid swing may then be increased without altering the load constants, but still keeping the operating path within the required area by modifying the direct current values, until the peak values of plate voltage or current reach a practical limit. The output under these conditions is known as the Maximum Undistorted Power.

The k_r and k_x values which determine an operating path that touches the boundary lines GD and GA may be derived with the aid of Fig. 2. By definition,

$$\frac{FQ}{QD} = \frac{\sqrt{2}\,\mu E_s}{QD} = R_p, \text{ so that } \mu E_s = \frac{QD}{\sqrt{2}} R_p.$$

Substituting this value of μE_s in the expression for I_1 first derived

gives $$I_1 = \frac{QD}{\sqrt{2}\sqrt{(1+k_r)^2 + k_x^2}}$$

and $$QD = \sqrt{2}\, I_1 \sqrt{(1+k_r)^2 + k_x^2}$$

Also $AQ = \sqrt{2}\, I_1$, so that $AQ + QD = AD$

$$= \sqrt{2}\, I_1 \left(1 + \sqrt{(1+k_r)^2 + k_x^2}\right)$$

and $$I_1 = \frac{AD}{\sqrt{2}\left(1 + \sqrt{(1+k_r)^2 + k_x^2}\right)}$$

But $$P_o = I_1^2 R_o = \frac{AD^2 R_p}{2}$$

$$\frac{k_r}{\left(1 + \sqrt{(1+k_r)^2 + k_x^2}\right)^2} = \frac{AD^2 R_p}{2} k_u,$$

where $$k_u = \frac{k_r}{\left(1 + \sqrt{(1+k_r)^2 + k_x^2}\right)^2} \qquad (8)$$

For maximum output, k_r and k_x should be so related that k_u is a maximum. Differentiating the expression for k_u with respect to k_x, equating to zero, and simplifying, gives

$$k_x^2 = \frac{2k_r^2 - 1 \pm \sqrt{8k_r^2 + 8k_r + 1}}{2}$$

It is known, and is apparent from the biquadraric equation which is solved to give this expression for k_x^2, that when k_x is zero, k_r has a value of two for maximum undistorted power. Substituting this value of k_r in the expression for k_x^2, the latter becomes zero only if the negative sign is used before the radical. Using the negative sign gives as a final form,

$$k_x^2 = \frac{2k_r^2 - 1 - \sqrt{8k_r^2 + 8k_r + 1}}{2}$$

for the locus of points on the several power circles representing maximum values of k_u. The abscissa of each point on this locus indicates the k_r value that gives maximum undistorted power, as just defined, when k_x is held constant at the corresponding ordinate value.

Phase Shift Curves

It is well known that in all amplifiers there is phase difference approaching 180° between the signal voltage and the output voltage. This phase difference varies with the character of the load, and it may readily be calculated.

The vector diagram of the circuit, Fig. 3, is well known. The phase difference referred to is represented by the angle *EOD*, which has the same sign as the angle *COD*. In the triangle *AOC*, angle *ACO* is equal to angle *COD*, and

$$\frac{CA}{\sin \angle COA} = \frac{AO}{\sin \angle ACO}$$

Transposing, $\sin \angle COD = \sin \angle ACO = \frac{AO}{CA} \sin \angle COA$

Substituting,

$$\sin \angle COD = \frac{I_1 R_p}{I_1 Z_o} \frac{I_1 X_o}{I_1 \sqrt{(R_p + R_o)^2 + X_o^2}}$$

$$= \frac{k_x}{\sqrt{k_r^2 + k_x^2}\sqrt{(1+k_r)^2 + k_x^2}}$$

This relationship holds for either inductive or capacitive reactance in the load circuit.

Inverting, squaring, transposing, expanding, and clearing of fractions, there appears

$$k_x^4 + (k_r^2 + (1+k_r)^2 - \csc^2 \angle COD)\, k_x^2 + k_r^2 (1+k_r)^2 = 0 \qquad (10)$$

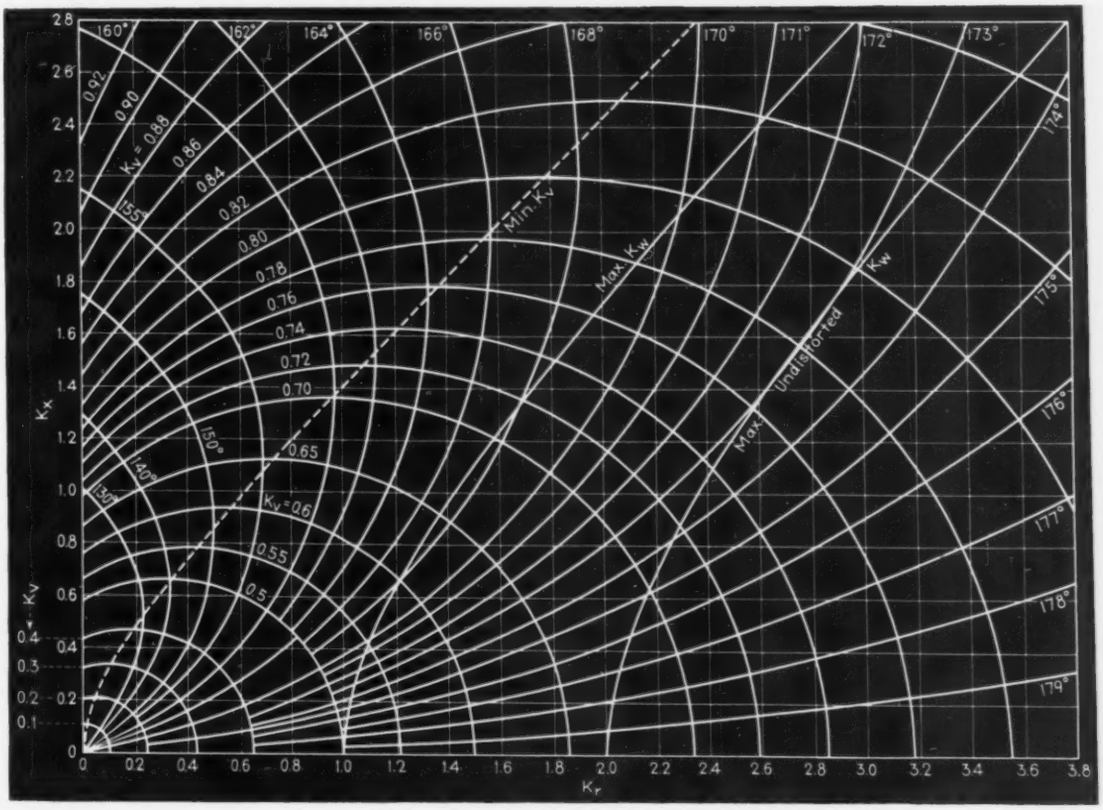
For plotting purposes, it is more convenient to solve this expression like a quadratic equation for k_x^2, giving

$$k_x^2 = \frac{\csc^2 \angle COD - k_r^2 - (1+k_r)^2 \pm \sqrt{(k_r^2 + (1+k_r)^2 - \csc^2 \angle COD)^2 - 4k_r^2 (1+k_r)^2}}{2} \qquad (11)$$

as the equation of the locus of k_r and k_x values which give a constant angle of phase difference.

Since equation (10) has no constant term, the loci for all values of the angle *EOD* pass through the

Fig. 4—Circle diagram for voltage gain. Relative values of external resistance and reactance are used instead of ohmic values to make the diagrams general in their application



Information available from circle diagrams

Item	Source
1. $k_r = 1$	Assumed.
2. $k_x = 1$	Assumed.
3. $k_v = 0.63$	Voltage Gain, or k_v circles.
4. $k_w = 0.2$	Power Output, or k_w circles.
5. Phase Shift $= 161.5°$	Phase Shift Loci.
6. The relative voltage gain is greater than minimum, with this value of k_r. For this value of k_x, minimum k_v occurs when $k_r = 0.62$.	Minimum k_v Locus.
7. The relative power output is less than may be obtained with either of these constants. With $k_r = 1$, it is possible to get $k_w = 0.25$; with $k_x = 1$, it is possible to get $k_w = 0.207$.	Maximum k_w Locus.
8. For maximum undistorted power, it is necessary to increase k_r to 2.34.	k_u Locus.

origin. Every locus shows a maximum value of k_r, which, curiously enough, appears to fall on the locus for minimum voltage gain. To see if this is significant, or merely a coincidence, solve the equation of the minimum voltage gain locus, equation (4), simultaneously with equation (10), for values of k_r and k_x. This gives

$$k_r = \frac{\csc \quad COD - 1}{2}$$

and $$k_x^2 = \frac{\csc^2 \angle COD - 1}{2}.$$

The expression for k_x^2 contains no ambiguous sign, so that there is only one positive value of k_x, which must be the ordinate corresponding to the maximum value of k_r. Since these two values were derived from the equation for the maximum voltage gain locus, the maximum points of the phase difference loci must fall on the maximum voltage gain locus.

The Curve Sheets

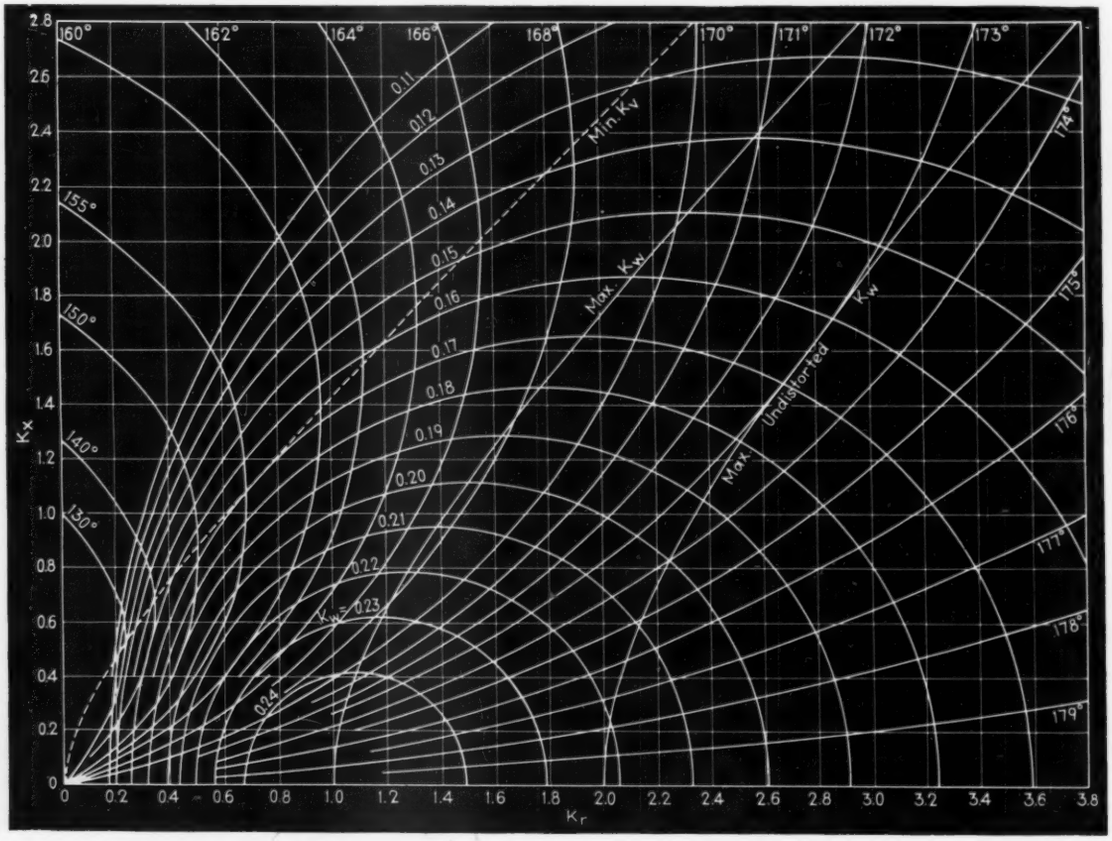
The circle diagrams for Voltage Gain and Power Output are best plotted on separate co-ordinates to avoid confusion. Phase Shift, Minimum Gain, and Maximum Output are conditions of interest in problems of either voltage gain or power output, so that cross reference from one curve sheet to the other is minimized by plotting these loci as a background for both kinds of circle diagrams.

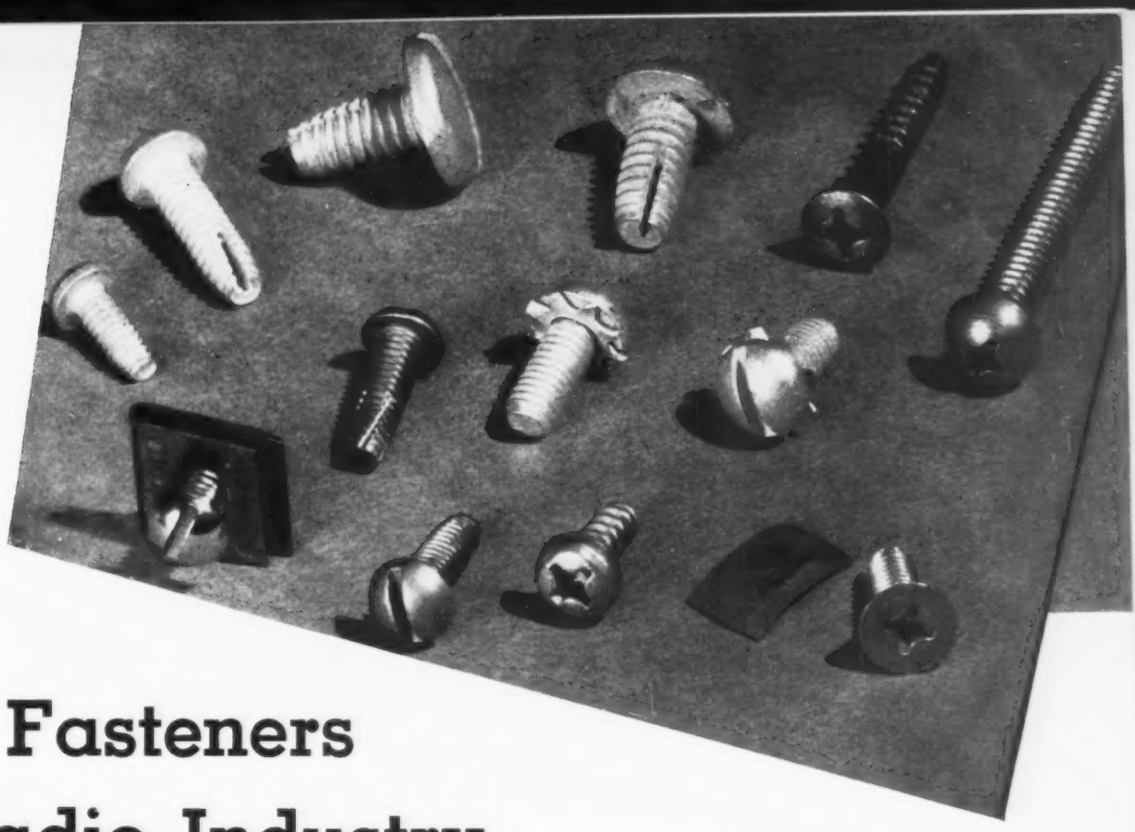
To illustrate the information which may be gathered from the curves, assume a point on each sheet and list the items which can be read. Purely for example, start by assuming k_r and k_x values each to be one. The table shows what information may be determined.

It is unnecessary to know or assume values of k_r and k_x to start with, as one of the chief uses of these curves is to determine the values of k_r and k_x which are implied by the specification of definite operating characteristics.

The application of these curves is not limited to tube circuits. They may be used equally well for any load impedance fed by an alternating voltage of μE_g through a transmission link of resistance R_p and negligible reactance.

Fig. 5—Circle diagram for power output. One of the chief uses of these diagrams is to determine the values of the external resistance and reactance from the operating characteristics





By
CRAIG WALSH
Assistant Editor

Modern Fasteners in the Radio Industry

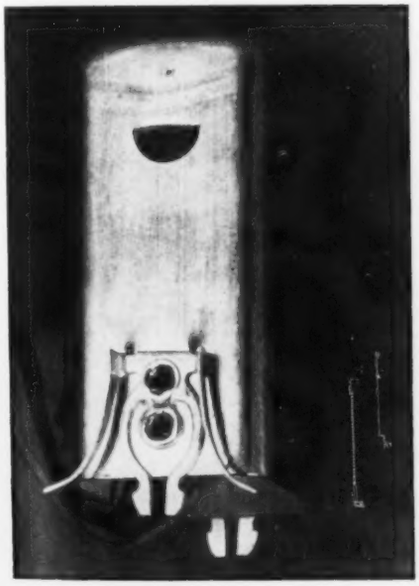


Fig. 1—Special device to fasten coil can to chassis quickly, tightly and permanently. The side springs hold it tight

THE radio engineer who is concerned primarily with the production of radio receivers and equipment would do well to focus his attention upon some of the recent developments in the art of fastening things together. Within the last year the familiar screw, nut, and lock-washer which have served so long, have been dressed up and combined in various ways so that they are now more efficient in assembly and in combating vibration and other forces tending to loosen their grips. Also, there have been several new devices developed for special purposes. It is the purpose here to describe some of the fundamental advances and a few typical examples, and to point the way to lower costs and increased reliability to the manufacturing engineer.

Modern fasteners are divided into two general groups; those for the purpose of reducing the cost of assembly of mass production articles and those for the purpose of increasing reliability where cost is of secondary importance. There is also that class of fastener which belongs in both groups.

In the front rank of improvements in screws is the Phillips recessed head. The recess is in the form of a cross or plus sign. This gives four driving surfaces instead of the two provided by the conventional slot and many advantages are claimed for it. The screw driver cannot slip from the recessed head to cause damage to the surface of the work, to the screw head, or to the operator. This in itself often represents a considerable item in cost. Assembly is faster because of the solid connection between the driver and the screw. Screws are not dropped to the floor and lost because the screw clings to the driver until it is in place. The head is stronger and will not break as easily as the conventional head. It is also claimed that Phillips screws can be driven tighter and have greater holding power and therefore fewer screws or a smaller size may be used. At the present time there are ten manufacturers making screws with the Phillips recessed head.

Thread-cutting Screws

In effect, a tap is provided with each Shakeproof and Parker-Kalon thread-cutting screw. The tapping and driving the screw are combined into one operation with the corresponding saving in time. The cutting surfaces of the Shakeproof are provided by cutting a slot in the side of the screw at the bottom and hardening the screw. The Parker-Kalon thread-cutting screw has a series of shallow slots around the screw at the foot of the thread to form the cutting surfaces.

Applications to Radio Set Manufacture

In some of the smaller Emerson receivers, the coil cans are fastened to the chassis with a special fastener designed for the purpose and shown in Fig. 1. The fastener consists of two spring hooks which, when pushed through the slot in the chassis, spread and must be pulled together with pliers or other suitable tool to remove the can. To prevent the can from moving slightly and causing noise in

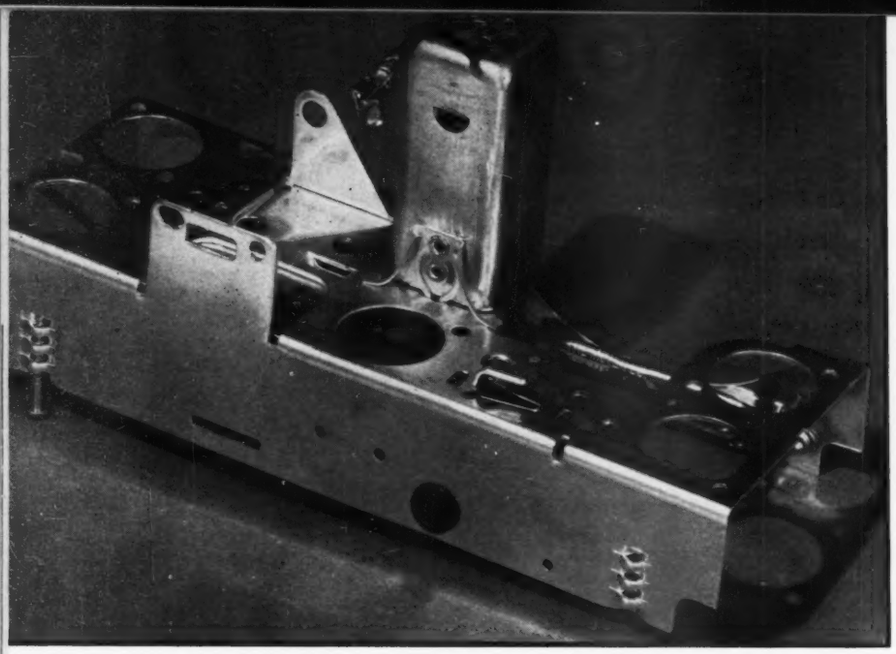


Fig. 2—The coil can is held tightly to the chassis by the side springs. The chassis sides are punched to provide screw holes in an edge-wise direction. Note the several brackets for fastening which were formed during the punching operation

the receiver, two springs are provided to hold the assembly tight. This type of fastener represents a saving in time of assembly over the conventional method of using spade bolts and nuts.

Emerson also uses an ingenious method to fasten the chassis to the cabinet. The side of the chassis is punched in such a manner as to provide a screw hole in the edgewise direction. This is shown in Fig. 2. A thread-cutting screw of the proper size is then inserted in the hole through the bottom of the cabinet.

For applications requiring a lock-washer under the head of a screw, fasteners by the name of "Sems" are provided. The lock-washer is placed on the screw before the thread is rolled and therefore it cannot move from its most efficient locking position nor can it fall off. Costs are reduced by eliminating the time necessary to place the lock-washer on the screw and to replace those which fall on the floor to be lost.

The Speed Nut is an ingenious device which combines into one unit the functions of both nut and lock-washer. It consists of a piece of sheet metal (spring steel, phosphor bronze, stainless steel, or cold rolled steel), slightly bent to form the arc of a circle, with a hole in the center to take the screw or stud, and two lips properly shaped to fit the thread. The Speed Nut holds the screw by engaging the thread, or surface of a threadless stud, and at the same time provides a strong spring action to keep the screw in tension so that it will not loosen. An application of especial interest is on an automatic selector bracket assembly shown in Fig. 4. Here a single Speed Nut replaced a coil spring, two washers, a drilled hole and cotter pin and gave a firm grip and the right amount of slidable spring tension.

By stamping two retaining ears near the bolt hole to provide a pocket into which a Speed Nut may be clipped, bolting in blind locations may be accomplished quickly and easily. They may be incorporated into strips or sheets of special shapes to fit special requirements. In applications where dismantling is necessary, a D-shaped stud and a special Speed Nut are used. By giving the Speed Nut one-quarter turn, it can be removed.

There are also available from Shakeproof and Parker-Kalon thread-cutting screws for plastics. Plastic materials require a slightly different thread-cutting edge than is necessary for other materials. A more acute cutting angle is provided in the Shakeproof Hi-Kook plastic thread-cutting screw by cutting a double width slot in the side of the screw. This is shown in Fig. 3.

A recent improvement in set-screw design is the use of a multiple spline socket instead of a hexagonal or square socket. This enables the power to be transmitted in such a manner that all of it is used to turn the screw instead of spreading or rounding the socket. Because the multiple spline design permits greater strength with smaller wall thickness, it is practical to make set screws in sizes as small as No. 4 wire size. Also, this design permit the use of soft alloys because

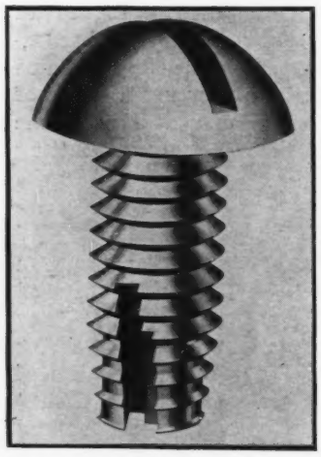


Fig. 3 — The Shakeproof thread-cutting screw for plastics has a staggered double-width slot

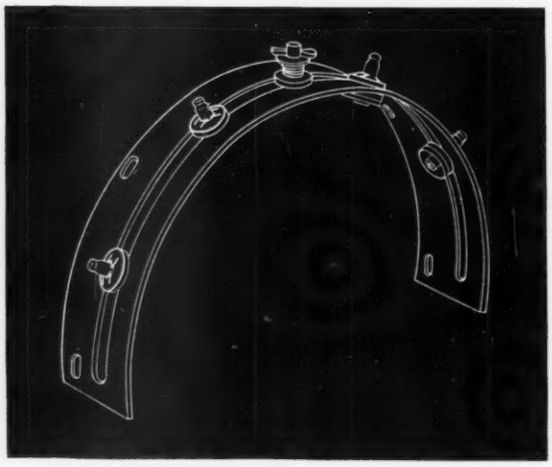


Fig. 4—In this automatic station selector bracket, a single Speed Nut replaced a coil spring, two washers, a drilled hole and a cotter pin and gave a firm grip and the right amount of sliding spring tension

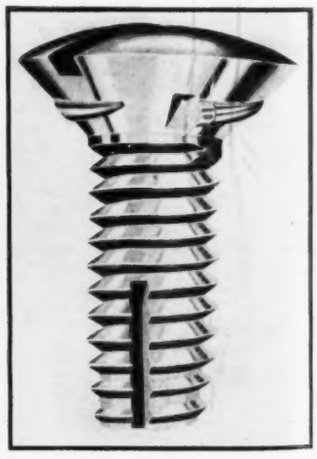


Fig. 5—The spurs of this locking thread-cutting screw force metal into the cavities to prevent any motion

of the lack of any tendency to spread the screw. This set screw is made by The Bristol Co.

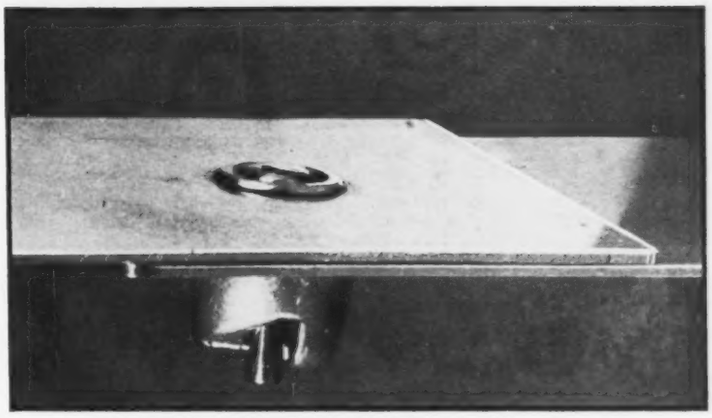
By using efficient methods supplementary to efficient fasteners, manufacturers can save much time and labor in asembly operations. As an example, one manufacturer has an arrangement whereby the multi-piece cabinet is held together with the chassis fastened to it by one set of fasteners.

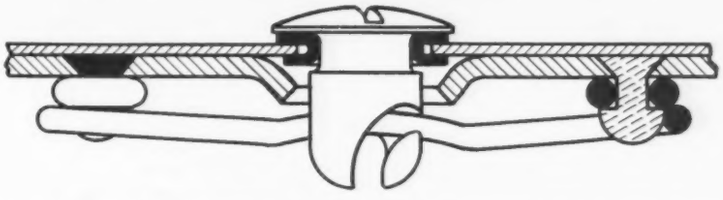
Vibration-resistant Fasteners

When the safety of life and valuable equipment depends upon the continued functioning of radio equipment, reliability of the component parts, including the fastening devices, is of utmost importance. Several fasteners have been introduced recently which are highly resistant to vibration and are quickly and easily detached. They find application in radio equipment which is to be used in aircraft, marine or police service and other applications where vibration is present or where it is desirable to be able to dismantle the equipment very quickly.

One of these, the Camloc fastener, consists of a stud assembly which fits into the outer plate and a cam with a detent which fits into the inner plate. The assembled fastener is shown in Fig. 6. The pin in the end of the stud rides up the face of the cam and slides into the detent as the stud is turned one-quarter turn. A spring exerts sufficient force to hold the pin in the detent during severe vibration. Because of its construction, it is impossible to operate this fastener falsely. It is attached by drilling one countersunk hole in each plate and flanging the stud assembly into the outer plate and the cam collar into the inner plate.

Another of these fasteners, made by the Dzus Fastener Co., consists of a stud mounted in the outer plate and a heavy spring wire mounted inside the inner plate across the center of the mounting hole. The stud has what may be termed a helical slot which engages the heavy spring wire. As the stud is given one-quarter turn, the spring rides up the helical slot and falls into a detent as shown in Fig. 7. Spring pressure keeps the wire in the detent during severe vibration and prevents detaching. However, detaching may be accomplished by giving the stud one-quarter turn.





Figs. 6 and 7—The Camloc fastener above, and the Dzus fastener below are used in applications where great strength and proof against vibration must be combined with speed of operation. Both make use of spring pressure to keep the fastening arm in a detent during vibration. A twisting force is used to operate them

The locking thread-cutting screw by Shakeproof, shown in Fig. 5, was designed for use as a permanent fastening for metal assemblies which are subjected to vibration and need not be dismantled very often. On the under side of the head are spurs which dig into the surface of the work and displace metal forcing it into solid projections which fit into cavities adjoining the spurs. If the screw is removed, it may be replaced with a standard machine screw.

A lock-nut which has wide application in resisting vibration consists of a standard nut whose height has been increased to accommodate a fiber washer. The increase in height is equivalent to the thickness of a lock-washer. As the nut is screwed on to the bolt, the threads of the bolt impress themselves into the fiber with the result that the fiber fits very closely to the bolt thereby providing constant pressure on the thread independently of the supporting structure. This prevents axial play between the nut and bolt and walking of the nut, and consequently, loosening during vibration. It may be removed and re-used indefinitely. It is made by the Elastic Stop Nut Corp.

In applications where high strength and shock resistance are required, a fastener such as the Aero-Thread screw may be used. An insert, formed by winding high tensile strength bronze spring wire in the form of a spiral, is screwed into the threads of a tapped hole where it becomes a fixed part of the tapped hole. In the final against the spiral bronze insert inassembly the screw bears directly stead of against the soft body metal.

Fig. 8—The power screw-driver used here with Parker-Kalon screws facilitates production

By FREDERIC D. MERRILL, JR.

for an ELECTRONIC PIANO...

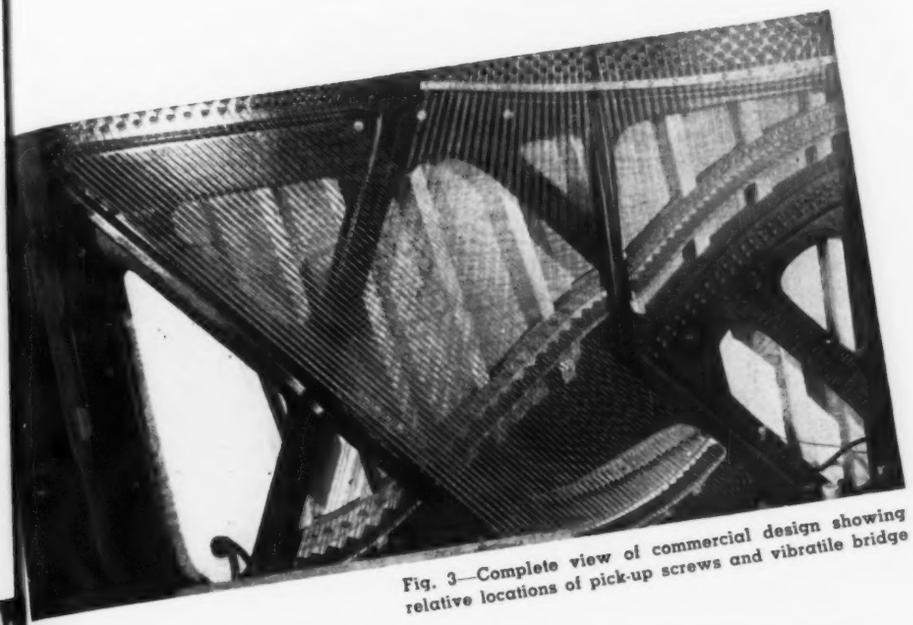


Fig. 3—Complete view of commercial design showing relative locations of pick-up screws and vibratile bridge

inserted in the cast iron plate. The vibratile bridge furnishes inter-string coupling, especially when the damper pedal is depressed, and must be retained for characteristic piano timbre.

For the wound strings in the bass, the pick-up screws should be just as near as possible to the string ends, close to vibratile bridge upper edge, to achieve high harmonic content in tone and low strength of fundamental (See Fig. 2). But the strip supporting the screws should not quite touch the vibratile bridge at any point to avoid spurious chattering vibration were the two in uncertain contact and also to lengthen the electrical leakage path. Above the wound string section the pick-ups taper about a half inch farther from the string ends. Figure 3 illustrates a commercial design in which the vibratile bridge and pick-up screw support are integral. The pick-up screws are removed considerably farther from the string ends than is suggested in this article.

The thickness of the material supporting the screws should be at least one-quarter inch so as to insure a firm support for the screws. Since we are dealing with the translation of minute vibrations, any movements foreign to those supplied directly by the strings themselves will generally introduce undesired components in the tone. For example, the length of screw outside its support is preferably kept short so that its natural frequency will be well outside that of any components in the string vibration itself. The flat surface of pick-up screw head will be just a turn or so beyond the string maximum amplitude position obtained by striking the key of keyboard hard. For the bass strings at rest, this distance may be nearly one-quarter inch while for the treble strings it may be as small as $\frac{1}{32}$ inch. It must be possible to thread the screw to just touch the vibrating string (the closest limit) and then about $\frac{1}{8}$ inch allowed for backing screw away from string to take care of loudspeaker volume regulation. Should the supporting strip be made too thick, then it may be found impossible to back the screw away sufficiently to reduce the volume to the same level as neighboring strings, or worse yet, one may not be able to get the screw head far enough away to prevent contact between head and string when key is struck hard. This limiting position is reached when the head is screwed in so far that it is flush with its support.

The location of all the strings is determined from a cardboard template made by stapling carbon paper to a cardboard strip shaped approximately like the bridge upper edge. The carbon surface is next to the cardboard, and its opposite surface is pressed against the strings so as to mark through their positions. With the upright piano this is carried out after the action and the keyboard have been removed, and piano placed on its back. After completion of the entire template, and computations of the thickness of strip to be used, the strings are loosened with the tuning wrench sufficiently so that they may be taken off the hitchpins only (not off the tuning pins; this would be unnecessary) and tied back out of the way while the bakelite strip carrying the pick-up screws is inserted.

One convenient size for pick-up screws is the standard one-quarter inch stove bolt with a half-inch head. This permits straddling the unisons. The ends opposite the heads of some of these screws must be slotted to permit voicing from the rear of piano where the action of the upright is normally in the way, preventing turning of screws from the front. In some cases a back beam or post may require a hole drilled through it in order to be able to get the screw end. A long screw can always be obtained by soldering a washer for the head on a threaded piece of drill rod. The surface of the head should be parallel with respect to the plane of the unisons to get an equal amount of pick-up from each. The screws are electrically connected together at the front by a five mil diameter steel piano wire forming a tight loop around each screw inside the thread. The wire must not vibrate or rattle against the screws or bakelite if disagreeable noises are to be avoided.

Practical DESIGN

Fig. 1—Left, each note has one pickup screw which is mounted symmetrically with respect to the strings for that note. Fig. 2—Above, in the bass notes, the pick-up screws should be close to the string ends to pick up high harmonic content and low fundamental strength

DURING the past year numerous electronic musical instruments such as organs, pianos, and orchestral instruments have appeared on the market. In the belief that radio engineers would like to combine their professional talent with pleasure to be derived from playing such a device, the following design data are offered.

Of the three classes of instruments available—the rotating tone wheel, oscillating vacuum tubes, and electric translation of tuned vibrators, such as strings, the last mentioned appears to be the easiest to construct, the cheapest, and to afford much pleasure in actual usage.

In the electronic instrument to be described the timbre is essentially pianistic, chords may be played, and the usual touch responsiveness of the piano is retained. By "touch responsiveness" we mean that the greater the key blow, the more strident and louder the tone becomes. The pick-up system, amplifier, and loudspeaker are comparatively inexpensive and simple.

The pick-ups consist of flat head machine screws mounted on a strip of bakelite as shown in Fig. 1. There is one screw for each note of the scale and this is mounted symmetrically with respect to the string or group of strings forming one note. For the upright piano, the bakelite piece carrying the screws is mounted on the soundboard just above the vibratile bridge towards the bottom of the instrument. The strings zig-zag across this bridge by the bridge pins and then terminate at the hitch pins

In the upright piano, a separate speaker amplifier cabinet can be avoided if the loudspeaker is mounted on front fall board under the keyboard at the right side of treble. The two amplifier chassis are mounted on the bottom board. The effective baffle area need not be large as the bass strings of the pianos with the soundboard never have generated strong fundamental tones. If too much output from the speaker is attempted, then acoustic feedback will result at some level. There is no certain cure for this except to keep below this level. One may also try backing off a pick-up screw a little more from the string causing the feedback. A flimsily constructed piano will cause more trouble than one in which the cabinet is sturdily constructed. If no definite howl has developed within three-quarters of a minute after depressing damper pedal and striking all keys hard, then the acoustic feedback can be considered negligible at that particular gain setting and speaker location.

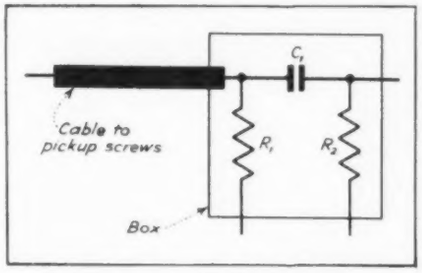


Fig. 5—To reduce microphonics and leakage noises, the input resistor, mica blocking condenser and the charging resistor are placed in a small sealed box

In placing the amplifier in the piano, if several widely separated grounding points are used, hum may result. The cure is to adopt a common point for grounding the shielded leads and to insulate the shielding from aquadagged surfaces.

If the loudspeaker and power amplifier are placed in a separate cabinet, then the placement of the pre-amplifier within piano will enable the cable joining the pick-up screws to amplifier input to be kept short. The whole instrument and especially the space between the pick-up screws and strings should now be blown out with a vacuum cleaner or hair dryer blower to remove all dirt, lint, etc. If the temperature rise within piano is excessive, more ventilating holes can be provided, but a little heat is beneficial for keeping the piano dry at all times.

Adjustment of Pick-up Screws

Assuming that the amplifier and loudspeaker are installed and the input cable connected to pick-up line, we can proceed to the adjustment of the pick-up screws. Two men are needed for this job—one to pound the keys hard (if three fingers are used simultaneously on one key, the wear on each finger tip is reduced proportionately!) and the other to turn the screws with a screw driver until the desired loudness is attained.

The process is as follows:—First, all the screws are brought to a point just a half turn off from hitting the string as it vibrates at its greatest amplitude. Next, with an a-c voltmeter across the loudspeaker voice coil, the strings giving weakest electric output are noted. The louder strings are now reduced in volume down to the level of the softer ones by backing the pick-up screws away from strings. The extreme bass and treble string outputs will drop off a little in volume compared with the general level in the middle register, but this is unimportant provided there are no sudden volume variations along the keyboard.

A poor timbre from a string may be caused by a loose winding on string, a scarcely visible kink, or too hard a felt hammer. For the first two cases, a new string is needed; for the third case the hammer may be needled a little by piercing the felt portion contacting the string with a darning needle so as to soften the felt.

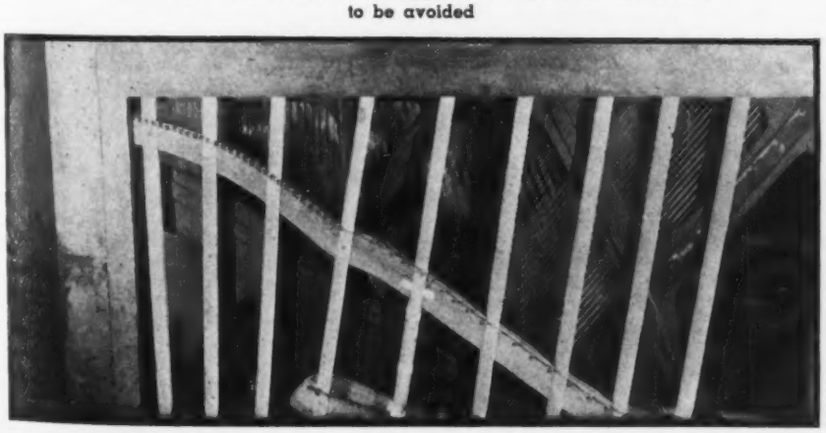
A pick-up screw may be just off hitting a string, yet still too close so that a poor timbre results. In the bass the effect will resemble a rattle; in the treble there will be a large plop component to the tone. Another precautionary check of the voicing of the bass strings is to hit the single key hard several times in fast succession.

The voicing may now be checked by merely listening to the scale runs over the keyboard and making comparisons of different sections of the range for volume. It should be obvious that in making all these adjustments the amplifier timbre controls are turned to give full bass and treble.

The screws, connecting steel wire, and strings are coated with a clear lacquer to prevent rusting and also to diminish leakage should a moist piece of lint get wedged between pick-up screw and string. The string coating should be light, but the coating over the screws and connecting wire should be heavy.

Some minor precautions to observe are as follows: A pre-amplifier tube may be microphonic at a particular frequency and give the effect of a hang-over in the tone. A leakage noise may be a steady rush noise or an irregular popping. With amplification turned off, striking each key will generally dislodge the particle between screw and string. A small home hair dryer can also be used to blow out the piano. If the noise still persists, remove cable attached to pick-up screws to learn whether the noise is orginating in amplifier or pick-up line.

Fig. 6—The pick-up screws are all connected together with five mil diameter steel piano wire. The wire must not vibrate or rattle against the screws or supports if extraneous noises are to be avoided



Bibliography:
B. F. Miessner—"Design Considerations for a Simple and Versatile Electronic Music Instrument"—Journal Acoustical Soc. of America, January, 1935, pp. 181.
B. F. Miessner—"The Application of Electronics to the Piano"—Proc. Radio Club of America, Jan. 1934, #1.

The screws must thread tightly in the bakelite to prevent loosening.

After the pick-ups are mounted, the next step is to saw out as much of the soundboard as possible, but the ribs which support the vibratile bridges are left intact. Cutting away the soundboard serves to diminish the residual acoustic output of the instrument so that the loudspeaker tone will predominate at nearly all volume levels. Also, any tendency for acoustic feedback between the vibratile system directly affecting amplifier input and loudspeaker is lessened. This is especially desirable where the loudspeaker and amplifier are to be mounted within the upright piano itself. Figure 6 illustrates the skeleton rib structure and shows wire connecting pick-up screws at rear rather than front, as may be done with a piano without back beams.

This completes the construction of the pick-ups, so now the strings are placed back on the hitch pins and brought up to normal tension. Several tunings spread over a week or two will be necessary to eliminate the initial stretch to the strings before they will again stay on pitch without going flat.

Electrostatic Shielding

All the inside cabinet surfaces of the piano must be made electrically conductive by painting with a colloidal graphite solution, such as Aquadag. If alcohol is used as the solvent, the liquid solution may easily be applied over varnished surfaces. An alternative and cheaper material is gold or silver paper found in stationery stores.

The upper right treble end is particularly sensitive to stray alternating electrostatic fields such as might be caused by a nearby lamp cord, so even here the painting must be continued. Also, at the bottom of the piano on the inside there is need for shielding of the lower bass pick-up sections. Where individual boards may warp, pull apart, and produce irregular electrical connection during the vibration of the instrument, a flat piece of copper braid is tacked across the junction. To avoid leakage or vibration noises due to intermittent contact grounding points, no part of the ribs or soundboard are painted.

A one-half inch thick plywood board painted on the outside with Aquadag serves to shield the back of the piano. A thin border may be painted on inside to make contact through to ground, but none of this should be near pick-up screws to avoid acoustic feedback.

When the paint is dry, the resistance from any parts of the Aquadag to the grounded cast iron plate supporting the strings should not measure more than 75000 ohms, and this is also an indication of how much the concentrated paste is diluted. In all not more than a half pint of Aquadag is needed. A lamp cord carrying alternating current and brought around the various parts of the piano will also serve to indicate the effectiveness of the shielding by watching the deflection of an a-c voltmeter across the voice coil or by listening to the speaker.

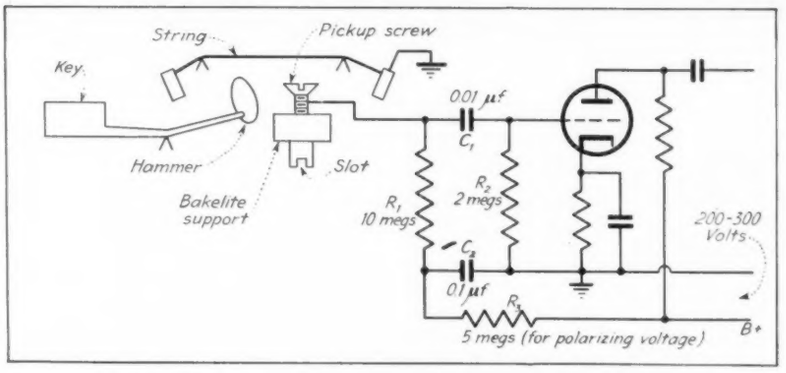


Fig. 4—110 db gain with a two-megohm input resistor is needed. The frequency range, which is not critical, extends from 60 cycles to 6000 cycles

The Pickup Amplifier

With a two-megohm input resistance, approximately 110 db gain is needed. The frequency range is not critical and need extend only from about 60 cycles to 6,000 cycles. The normal soundboard piano has very low output from the fundamentals in the 30 to 60 cycle range. The power output needed from the amplifier depends on the use to which the instrument will be put, but 15 watts, such as supplied by two 2A3s in push pull, are sufficient for most homes. For commercial entertainment, a pair of 6L6Gs in push-pull with about twenty per cent inverse feedback is entirely satisfactory. Non-linearity in the amplifier cannot be tolerated, as it will quickly show up especially when playing chords in the treble, and is recognized by a difference frequency component.

The input circuit to the amplifier is the same as that customarily used with condenser microphones. To diminish microphonics and leakage noises, the input grid resistor, mica blocking condenser, and charging resistor are preferably sealed into a small box filled with roofing tar or dry battery sealing material.

The amplifier controls consisting of 110 volt toggle switch with pilot light, volume control, treble timbre control (potentiometer and fixed shunt condenser grid to ground) and bass tone control (potentiometer with fixed condenser in series with grid of amplifier) are mounted on a small panel board within easy reach of player. The parenthetical expressions indicate the definition adopted for bass and treble tone control as these terms are sometimes confusing.

It is desirable not to go below a fifteen inch speaker size if clear tones at good volume are wanted. Permanent magnet speakers do not seem able to stand the strong transients without developing rattles or whisker tones. Any metal nameplate on speaker back is likely to produce buzzy tones at a particular resonant frequency and should have a piece of cardboard wedged in back of plate. The limit of the power that the speaker can handle is reached when a single note (one key of piano struck hard) in treble produces cone break-up. This is detected by an octave lower frequency component which appears to "burst" through when a certain volume level is reached. Regardless of which form of distortion appears first—amplifier cross modulation or speaker cone break-up—an auxiliary volume control on pre-amplifier must be locked at the point above which pronounced distortion appears. Then the regular panel volume control knob accessible to the pianist cannot carry the amplifier above the point at which poor reproduction starts.

NEW BOOKS

Fluorescence and Phosphorescence

E. HIRSCHLAFF,
Ph.D. Chemical Publishing Co. of N. Y. Inc. 1938. 128 *pages*, 42 *diagrams. Price*, $1.50.

WITH THE ADVENT OF TELEVISION, fluorescence and phosphorescence are of increasing importance to the electronics engineer. This book treats the subject from a theoretical chemical viewpoint rather than from a physical and electrical viewpoint. Fluorescence of vapors and liquids, and fluorescence and phosphorescence of solids are covered in some detail, including a discussion of acceleration and quenching. There are short references to the technical applications of fluorescence an phosphorescence including screens of television tubes, and fluorescent lamps. An extensive list of reference works is given. The information given in this book would be of considerable value to those engaged in the manufacture of television tubes and of lesser value to those engineers who only use television tubes. —C. W.

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Moderne Mehrgitter—Elektronenröhren Zweiter Band

(Modern Multigrid Electron Tubes, Vol. II)

BY DR. M. J. O. STRUTT
Published by Julius Springer, Berlin, 1938. Price RM 13.50, 144 pages.

THIS BOOK IS the second of two volumes which deal with the construction, operation, and characteristics of the vacuum tubes used in modern radio receivers. The first volume, in which the properties of such tubes were discussed mainly from the point of view of one who uses the tubes, was reviewed on page 51 of the May, 1938, issue of *Electronics*. The material which is presented in the second volume is of particular interest to those who are concerned with actual tube design.

The author devotes approximately the first third of the book to a discussion of subjects mainly relevant to the design of vacuum tubes which are to operate at low frequencies. This material is introduced with an exposition of the fundamental equations of motion of electrons in electric fields, and in combined electric and magnetic fields. The analogous behavior of a mass-particle subject to gravitational forces is treated, and it is shown how application of the similarity between the behavior of the electron and the mass-particle can be made to determine electron trajectories in model tube structures, in the absence of space charge. The author then proceeds to develop the equations of current flow in a diode with various assumed types of velocity of emission of electrons from the cathode, including the important practical case of a Maxwell-Boltzmann distribution of velocities. This treatment is extended to the derivation of the approximate equations of current flow in a triode, including the effects of the variation of the potential between grid wires, and the modifications resulting from the phenomenon of sectional cut-off of the cathode. Variable-mu tube design is also briefly discussed. It is then shown how the formulas for the static capacitances of plane and cylindrical triodes are derived and applied to the calculation of the amplification factor for such tubes. As an illustration of the application of the method of integral equations to such problems, the author calculates the capacitance between two parallel grids.

This material is so well and otherwise so thoroughly presented, that it seems remarkable that no formulas are given for the amplification factor for triodes in which the grid is wound with relatively thick wire. Such formulas have been given by Vogdes and Elder (*Physical Review*, Vol. 24, p. 683, 1924); and by Ollendorff, reference to whose work is given in the author's first volume. Formulas for the amplification factors for multigrid tubes are also omitted: such formulas have been developed, for example, by Koizumi (*Journal I.E.E. Japan*, Abstracts, Vol. 10, p. 18, 1934).

The author devotes most of the remainder of the book to subjects which are of particular importance in the design of multigrid tubes, both at low and at high frequencies. This material is introduced with a discussion of the important effects of space charge in the screen grid-anode region of an ideal tetrode, and application is made to the problems involved in the design of multigrid amplifier tubes, mixer tubes, and power amplifier tubes. The effects of the presence of space charge on the interelectrode capacitances are then treated, and pertinent experimental data obtained on typical European tubes are presented. The high frequency behavior of tubes is introduced by representing the action of a tube as an active quadripole, the parameters of which are complex functions of the frequency, the tube lead impedances, and the electrode voltages and spacings. The dependence of the quadripole parameters upon these factors is then treated briefly. The high frequency phenomena encountered in various types of mixer tubes are discussed in some detail, the discussion being supplemented by experimental data obtained on Philips tubes.

The final sections of the book are devoted to brief treatments of tubes in which the electron paths deliberately have been curved, such as the recently announced Philips mixer and secondary emission amplifier tubes; a discussion of recent theoretical advances in tube noise theory, with application to the construction of low-noise tubes; and a few remarks on electrode temperature. The book concludes with an appendix which contains the detailed development of several formulas used in the text, a bibliography of 68 references to the international literature on the subject, and an index.

This volume, like the first, is paper-covered, but the printing and 98 figures are excellent. The book is well written and its material is up-to-date. However, the presentation of so much material in so few pages—the book could very easily be expanded to one twice its size, with profit—would seem to make the book far more suited to the specialist than to the beginner. Nevertheless this work is the only one of its kind, as far as this reviewer is aware, and for the library of the vacuum tube design engineer the book must therefore be regarded as being indispensable.—BERNARD SALZBERG

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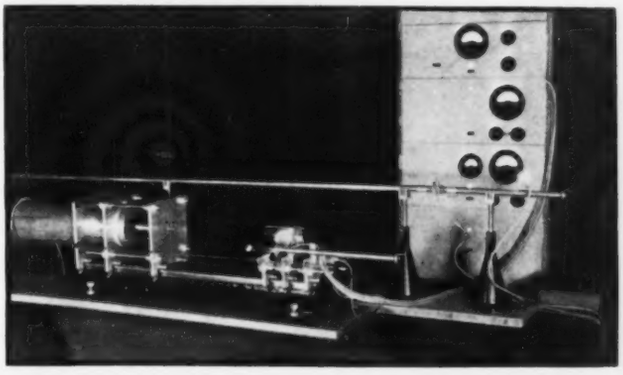
Handbook of Technical Instruction for Wireless Telegraphists

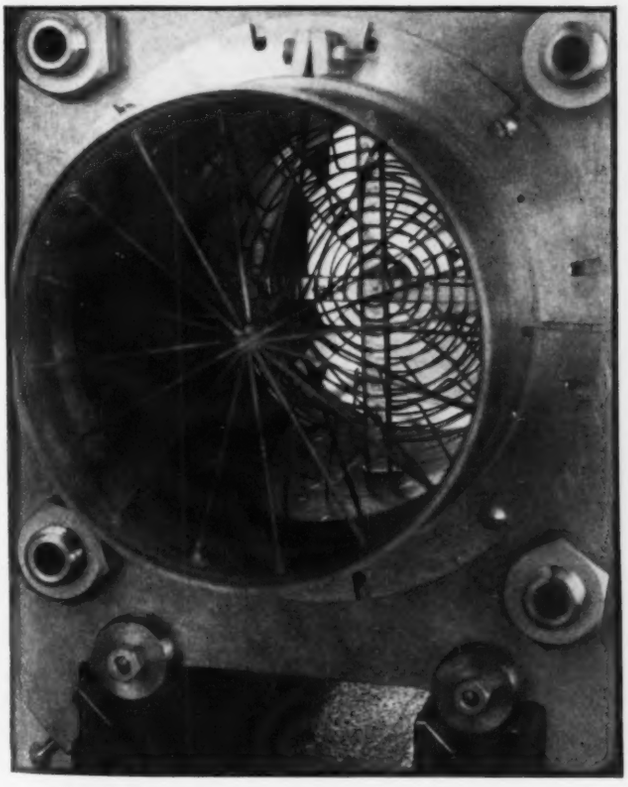
BY H. M. DOWSETT, *M.I.E.E., F Inst. P, M. Inst. R. E., Iliffe and Sons Ltd., London, Sixth Edition, 1939, 618 pages, numerous illustrations, 21 shillings.*

Marine radio operators will find this book useful, especially if they must be familiar with British equipment. The general theory of electricity is covered with particular reference to radio applications. Considerable space is devoted to descriptions of current models of commercial equipment. In the preface, the author states, ". . . when once a set is installed on a ship it may be years before it is replaced by another. During this period of years it may come under the charge of several operators, so that the descriptions given remain of practical use for a considerable time. . . ." Some of the subjects covered are: The Electric-Charge, The Condenser, Direct Current, Scaler and Vector Quantities, Batteries, Magnetism, Induction, Rotating Electric Machines, Measuring Instruments, Switchgear, Alternating Current, Spark Transmitters, Aerials, Valve Transmitters and Receivers, Direction Finders, Emergency Outfits, and Maintainance of Equipment.—C. W.

Exploring the Microwaves

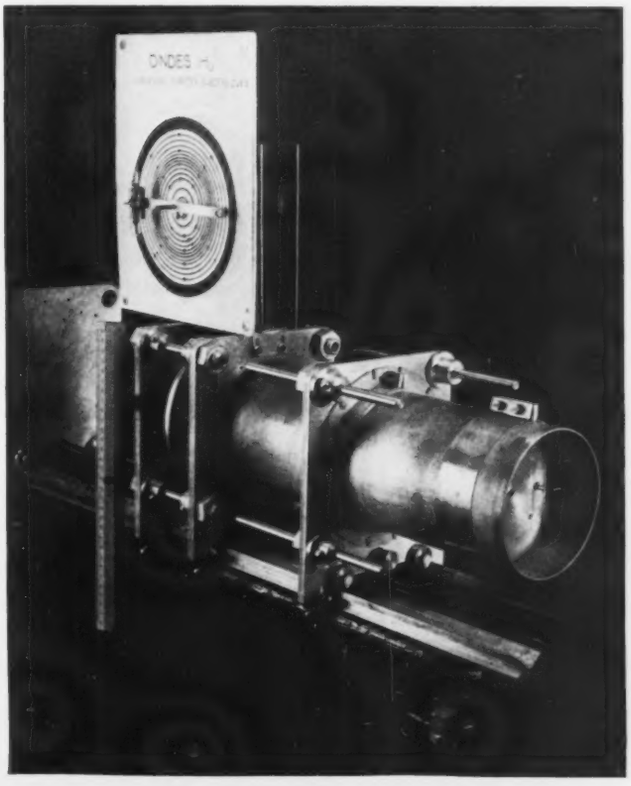
Microwaves of the order of five-cm wave-length are being investigated in the Paris laboratory of the International Telephone and Telegraph Corp. In the center below is a microwave generator of the Lympne-St-Inglevert type designed for an eight-cm wave-length. On the right is the associated wave-meter and on the left is a 12 cm dielectric guide into which the energy is directed

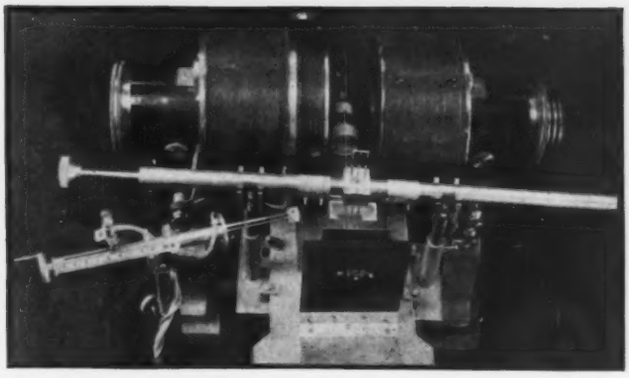




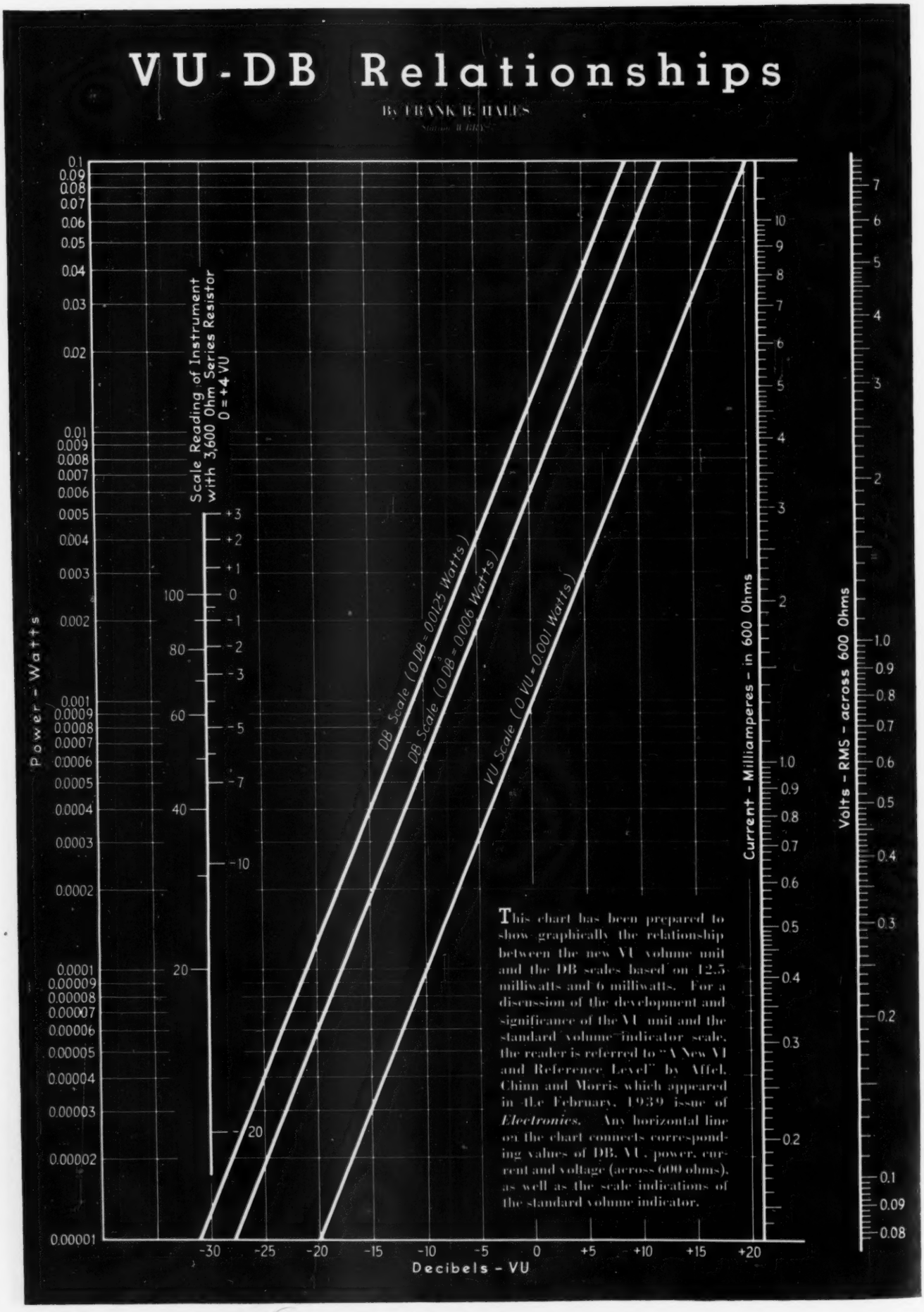
The apparatus above is used to transform one type of wave into another (in this case E_0 wave into H_0 wave). The main part, in the middle of the apparatus, is made of a number of broken line wires, the center of which builds up an almost complete metallic circle oscillating in phase. This is a suitable structure to launch an H_0 wave into the wave guide. Transmission takes place from back to front

Close-up of the receiving apparatus used on the 12-cm dielectric wave guide. It was designed to show the phase velocity and the distribution of electric lines of force for different types of waves (E_0, H_0, H_1). The antenna can be slid lengthwise and rotated inside the guide to probe the distribution of the lines of force and to indicate the type of wave being generated





This generator produces a wave of 2.5 cm in air. The oscillator is a diode magnetron with a three wire parallel line coming out of the bulb and suitably tuned by means of an adjustable screen. To this line, another three-wire line is coupled, the center wire only getting through the guide to send an H_1 wave inside. A piston is used to adjust the termination of the guide. A wavemeter is on the left


VU-DB Relationships
By FRANK B. HALL
Power - Watts
Scale Reading of Instrument with 3,600 Ohm Series Resistor 0 = +4 VU
DB Scale (0 DB = 0.0125 Watts)
DB Scale (0 DB = 0.006 Watts)
VU Scale (0 VU = 0.001 Watts)
Current - Milliamperes - in 600 Ohms
Volts - RMS - across 600 Ohms
Decibels - VU
This chart has been prepared to show graphically the relationship between the new VI volume unit and the DB scales based on 12.5 milliwatts and 6 milliwatts. For a discussion of the development and significance of the VI unit and the standard volume-indicator scale, the reader is referred to "A New VI and Reference Level" by Affel, Chinn and Morris which appeared in the February, 1939 issue of Electronics. Any horizontal line on the chart connects corresponding values of DB, VI, power, current and voltage (across 600 ohms), as well as the scale indications of the standard volume indicator.

ELECTRONICS REFERENCE SHEET

The selection of IRC Resistors and Volume Controls by manufacturers of recently announced Television Receivers, Transmitters and Testing Equipment is impressive evidence of the soundness of IRC engineering progress and accomplishment.

IRC's successful development of many types of Fixed and Variable Resistors is the result of intensive specialization on the resistance problems of the entire electrical industry

INTERNATIONAL RESISTANCE COMPANY, PHILADELPHIA, PA.

TUBES AT WORK

Noise-silencing circuit arrangements, a shunt-excited u-h-f antenna, methods of calculating multi-winding transformers, and a loudspeaking burglar alarm are among the applications discussed this month

Noise Rejection Circuits

By WILLIAM RUSSELL
Represa, Calif.

MOST OF THE interference countenanced in reception of radio signals is caused by electrical equipment and appurtenances in close proximity, X-Ray machines, automobile ignitions, etc.

A method which is usually effective against explosive type interference is the noise rejector application used in the intermediate frequency circuit of a superheterodyne. The method operates in such a manner that it causes the noise impulses to recede to zero before they reach the second detector stage. Fig. 1 outlines the circuit of this rejector as applied to the second intermediate frequency stage.

Noise voltage which is in excess of the desired maximum i-f amplifier input voltage is removed from the grid of the intermediate frequency amplifier, amplified by a noise amplifier stage, and put through a process of rectification by a full-wave diode rectifier. The rectified noise voltage is applied as a pulse of negative bias to the number three grid of the 6L7 pentagrid mixer amplifier in the second i-f stage. This noise voltage wholly or partially blocks this stage for the duration of the noise depending entirely upon the amplitude of the noise voltage.

The noise-amplifier circuit is biased by means of the threshold control, so that the process of noise rectification will not commence until the voltage is in excess of the signal-amplitude desired. When desiring reception with automatic gain control, the automaic gain control voltage is also applied in conjunction with the threshold bias to augment the threshold bias. This method of noise rejection provides an improvement in signal-noise ratio of 30 decibels.

In a communication receiver, the application of the noise rejector to a stage following that employing a crystal filter is non-effective in the reduction of noise interference due to the reduction in peak-to-effective voltage ratio and the length of the noise wave trains in the high selectivity circuit. The rejector must be employed to get at the noise before this occurs, so that it must precede the crystal filter.

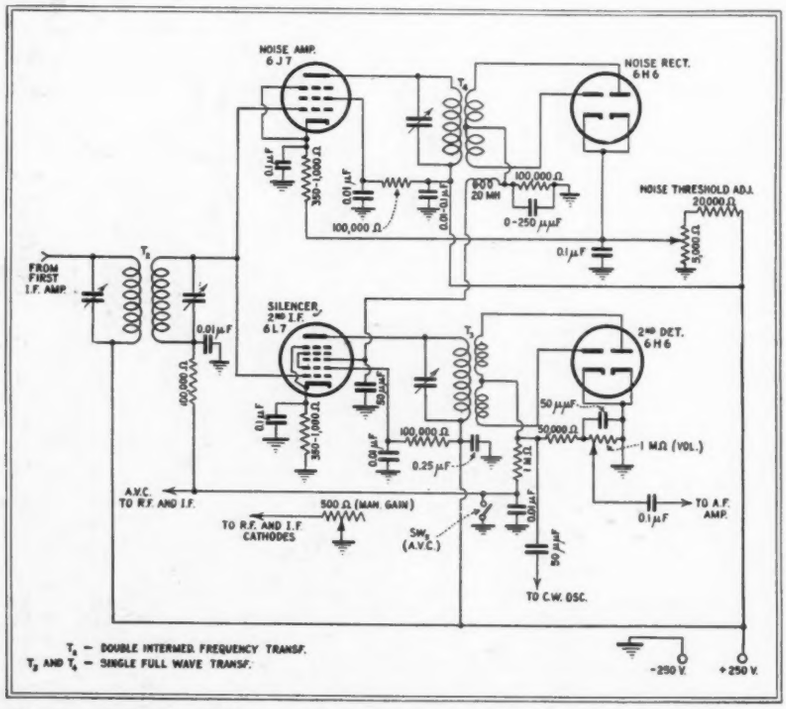


Fig. 1—Noise silencing circuit as developed by J. J. Lamb. Rejection circuit is applied to the second stage of the i-f amplifier

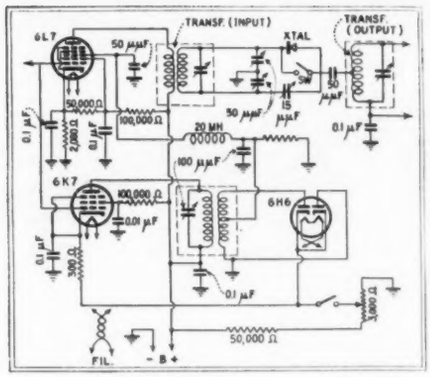


Fig. 2—Circuit diagram of crystal filter and noise silencer unit

A circuit which will accomplish the desired effect is shown in Fig. 2. It operates in a like manner as the second intermediate stage, except that the gain of the 6L7 stage is minimized and its noise-control sensitivity is increased to insure action at a lower amplification level. To accomplish this the screen voltage obtained from the screen-cathode voltage divider must be reduced. This voltage reduction also provides a reasonably high cathode drop bias on the signal and silencer grids. A further improvement in signal-noise ratio is made possible by the combining of the rejector circuit and crystal filter.

The noise rejector and crystal filter unit as shown in Fig. 1 is designed for the communication receiver of high fidelity and performance, but may be used with good results by any receivers employing one or two stages of intermediate frequency.

The 6L7 tube is, as before stated, a pentagrid mixer amplifier preceding the crystal filter; the silencing voltage is applied to its #3 injection grid. The 6J7 and the 6H6 are the noise amplifier and rectifier. Before the signal reaches the crystal, silencing takes place, preventing shock excitation of the crystal by the noise voltage.

B. S. McCutchen has devised a circuit which has been applied to a superheterodyne receiver. It will be noticed that from Fig. 3 the intermediate frequency stage and the audio stage are not changed.

The pair of diode elements on the left of the 6H6 are connected in the standard manner and comprise the signal detector. The load resistor is attached in series with the diode section and serves a purpose which will be given later. The pair of diode elements on the right, together with the anode bias battery and potentiometer form the noise gate. The two diode elements shown underneath the load resistor are helpful in keeping the gate closed in the presence of severe noises. The double pole switch places the rejector in and out of operation and prevents the discharge of the anode bias battery through the potentiometer while not in use.

A circuit which will provide amplitude limiting for noise pulses and which is valuable for maintaining approxi-

It's

"TOPS"

for 50 Kilowatts!

OWNERS of Western Electric high efficiency "Doherty" transmitters are enthusiastic about the performance they're getting from their 298A Tubes. And here are nine design features that insure the greatest transmitter tube value per kilowatt of output of any tube now in service:

1. Brazed copper water jacket is a permanent part of the tube.
2. Heavy copper grid lead-in and support allows safe operation at higher frequencies than are possible with other tubes of comparable ratings.
3. New tube mounting facilitates quick changes.
4. Jeweled expansion bearings give long mechanical life.
5. Grid made of tantalum laterals welded to six heavy conducting supports.
6. Copper to glass seals used for all lead-ins permit operation without cooling air streams.
7. Exact filament voltages supplied for the rated emission in tube booklet to encourage maximum tube economy.
8. Filament tension spring located in the coolest portion of the tube.
9. Extra large, pure tungsten filament assures long burnout life and low tube hour costs.

RATING INFORMATION

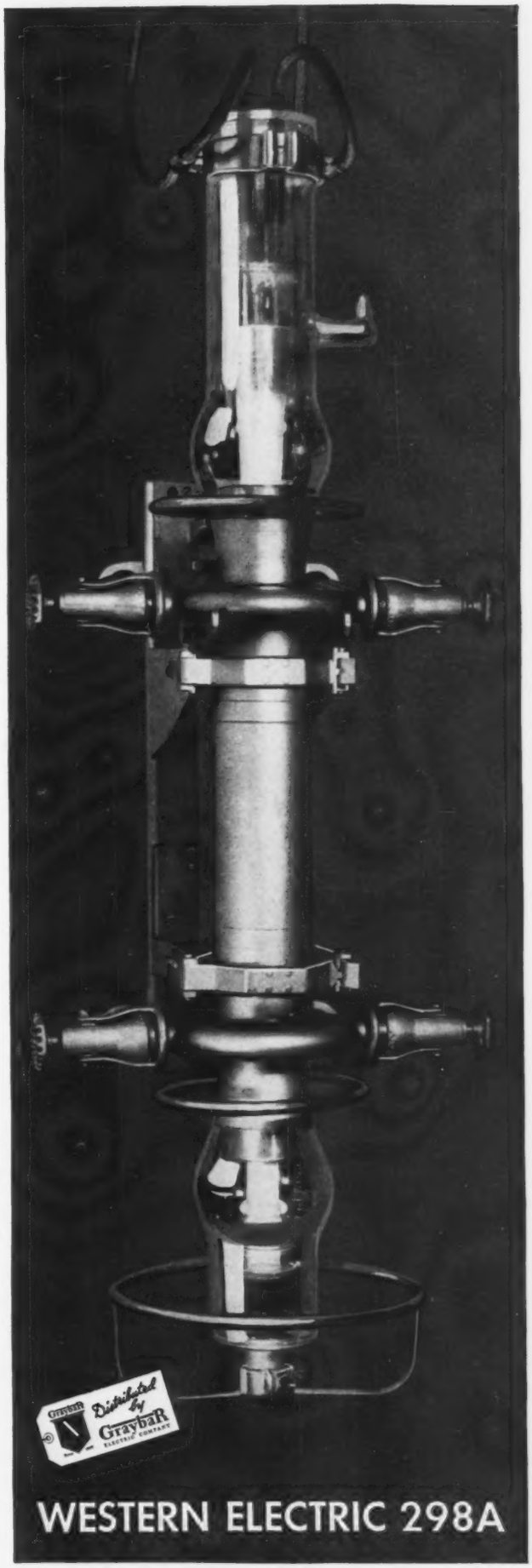
Nominal Filament Voltage	27 volts
Average Filament Current	22.5 amperes
Average Filament Emission	35 amperes
Amplification Factor	32
Average Plate Resistance at 18,000v. and -250v. bias	1450 ohms
Transconductance	22,000 micromhos
Normal Water Cooling Flow	35 gals. per min.
Maximum Plate Dissipation	100 kw.
Maximum Plate Voltage	20 kv.
Maximum Plate Current	11 amperes
Approx. Inter Electrode Capacities	
Plate to Grid	48 mmf.
Plate to Filament	10 mmf.
Grid to Filament	31 mmf.

Western Electric

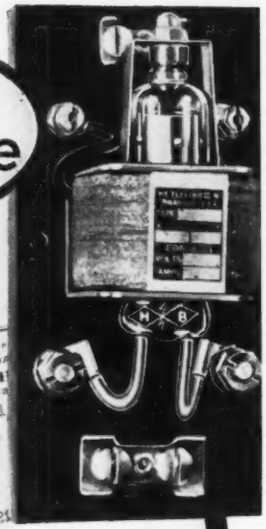
ELECTRONIC EQUIPMENT

DISTRIBUTORS:

Graybar Electric Co., Graybar Building, New York, N. Y. *In Canada and Newfoundland:* Northern Electric Co., Ltd. *In other countries:* International Standard Electric Corp.



"...we found your engineering service invaluable"...



H-B ELECTRIC COMPANY, INC.
MANUFACTURERS OF H B ELECTRICAL DEVICES

2818 NORTH BROA
PHILADELPH
BALDWIN

January 11

Continental Diamond Fibre Company
Newark, Delaware

Attention: N. N. Wright

Subject: Our Purchase Order #1121

Gentlemen:

The above order has just been completed and we did not feel that we would be doing your company justice by merely receiving the goods and marking the order complete, without dropping you a line and letting you know how we appreciate Continental Diamond service and engineering.

In the developing stages of our new mercury plunger relay we were somewhat handicapped for outside assistance in the proper selection of insulating material to complete this new product, but in working with Continental Diamond Fibre Company we found your engineering assistance invaluable in helping us solve our insulating problem. We were able to find just what we were searching for in the latest up-to-date material so that the finished product could be classified among the finest.

We, therefore, take this opportunity of thanking you for your splendid cooperation and assistance in putting this new product across with some of the largest electrical manufacturers in the country, who have accepted the unit and are adopting it for use with their equipment.

Very truly yours,

H-B ELECTRIC CO., INC.

Norman McKinney

Norman McKinney

NMcK:CK.C

◆ In the Continental-Diamond expertly staffed research laboratory—electrical equipment manufacturers have at their disposal—the industry's most complete physical and electrical testing laboratory. Use C. D. engineering to assist you solve your insulating problems just as H-B Electric Company did when designing the Mercury Relay show above and again below in the assembly line.

CONTINENTAL DIAMOND FIBRE CO.
NEWARK, DELAWARE

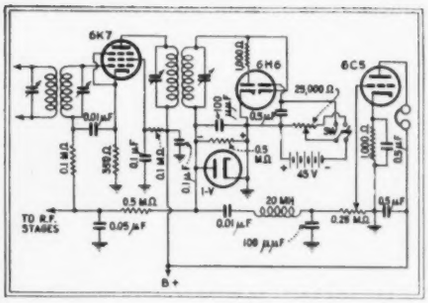


Fig. 3—Silencer circuit using a double diode in a "see-saw" arrangement for noise reduction

mate constant continuous wave signal output with fading is shown in Fig. 4.

This is an adaptation from the limiter circuit as used in a R.C.A. communications receiver.

The signal from last i-f transformer is detected in the number one diode section and the useful audio-frequency signal voltage is taken off across the 500-000 ohm load resistor. The number two diode section of the same tube is in shunt with this resistor; its anode being biased negatively in respect to its cathode from the voltage obtained across the 3000 ohm potentiometer. Noise or

ROBOT RADIO POLICEMAN

William J. Cox, left, and Dr. Miller McClintock, Director of the Bureau for Street Traffic Research of Yale University, are shown inspecting the robot radio policeman recently demonstrated before the Greater New York Safety Council. More effective control of traffic through the application of electrically operated equipment is expected to result from the installation of equipment such as this

DO YOU KNOW

...THAT THERE IS A

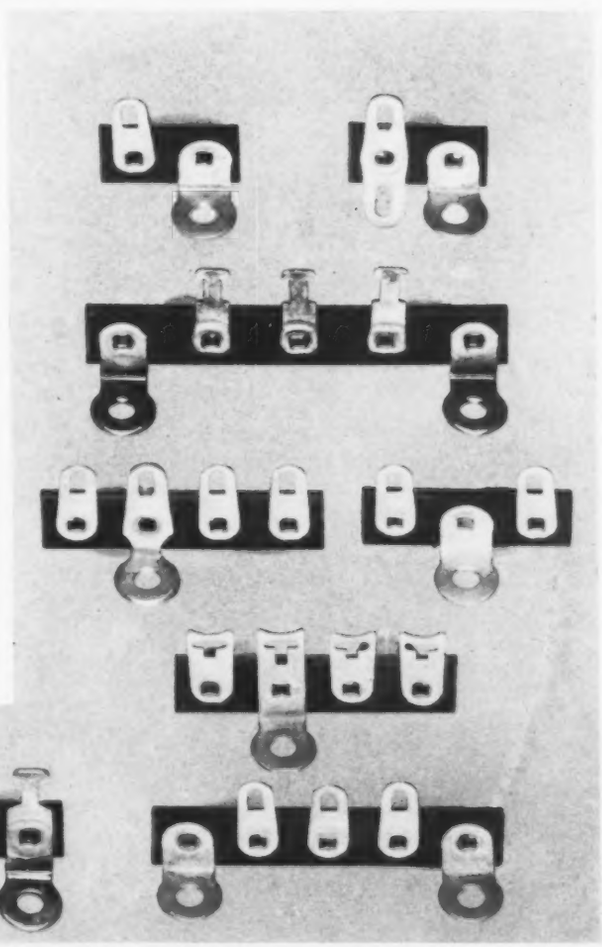
CINCH TERMINAL STRIP

SPECIFICALLY FOR

YOUR NEED?

For every model, for every need, you can get a terminal strip, exactingly made of finest quality materials. As production methods progress and conditions change, Cinch keeps pace—contributing maximum efficiency in terminal strips for existing requirements. Originated and designed by Cinch, nearly a decade ago, these terminal strips have served a wide variety of uses continuously and satisfactorily.

Each component part is fabricated and each terminal strip assembled entirely by "Cinch". Easy to solder... actually saves installation time and labor! The savings due to improved facilities and most modern manufacturing methods are passed on to the user.



Hundreds of variations, all styles in stock—afford prompt shipment on any requirement.

Cinch and Oak Radio Sockets are licensed under H. H. Eby socket patents.

CINCH MANUFACTURING CORPORATION
2335 WEST VAN BUREN STREET, CHICAGO, ILLINOIS
SUBSIDIARY OF UNITED CARR FASTENER CORPORATION, CAMBRIDGE, MASS.

Eimac Tubes and AIRTRACK

combine to make air-travel safe!

Airtrack Portable BLIND LANDING Transmitter

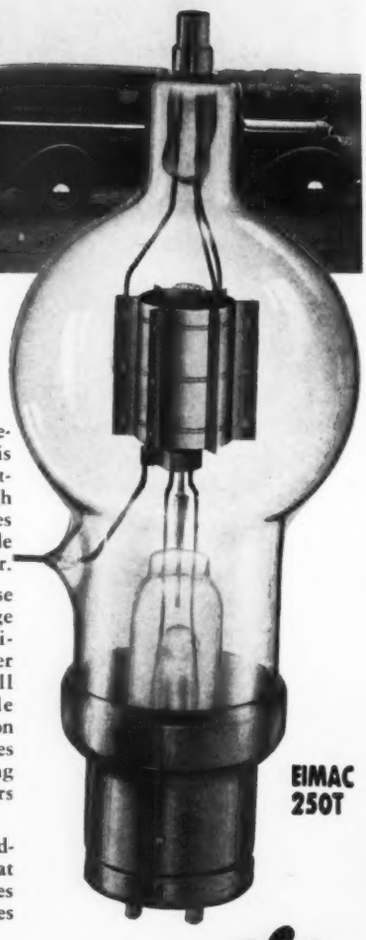
● OF THE recent developments in ultra high frequency transmitters perhaps the most interesting is that of the Airtrack Manufacturing Co., whose portable equipment has been installed in the Pittsburgh Airport for the past year. This transmitter produces a high frequency beam down which aircraft may glide to a safe landing during the worst kind of weather.

Airtrack Blind Landing System consists of a 4 course localizer beacon operating within the airway range beacon frequencies; an ultra high frequency, unidirectional, glide-path beacon and a radio marker beacon operating on the localizer frequency. All ground equipment is mounted in an automobile trailer so that it can be towed from one ground station to another at a moment's notice. This feature makes it possible to direct the glide-path beacon according to existing weather conditions. The three transmitters are controlled from the central tower board.

It's plain that equipment of this sort must be dependable; every part must perform at absolute "peak" at all times. As in all transmitters, the vacuum tubes play the most important part. Naturally Eimac tubes were adopted.

Ruggedness, dependability, complete freedom from the likelihood of tube failure due to gas released internally and ability to deliver outstanding results are a few of the reasons why Eimac tubes were selected. Airtrack engineers find Eimac tubes easy to neutralize and obtain overall efficiencies of 60 per cent, while an output of 400 watts through a pair of 250TH's operating at 125 megacycles is common.

Two Eimac UH51 tubes are used as doublers, two 100TH's as drivers and two 250TH's as power amplifiers. Proof again that "Among the outstanding NEW developments in radio, it's Eimac tubes every time."



EIMAC 250T

Eimac TUBES

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIF.

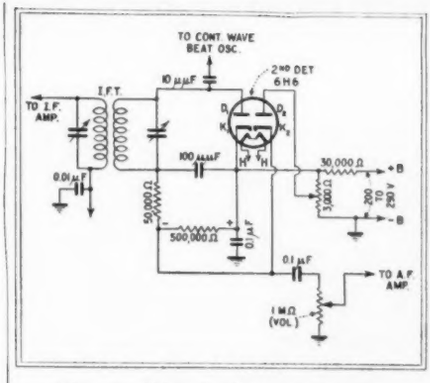


Fig. 4—Noise and signal limiting circuit for a detector

pulses of sufficient strength, great enough to cause the voltage across the 500000 ohm load resistor to exceed the negative bias on diode two, will cause diode number 2 to draw current and make possible a low impedance across the diode load circuit, thereby limiting the noise and signal output.

• • •

Loudspeaker System Routs Farm Prowlers

By H. H. SLAWSON

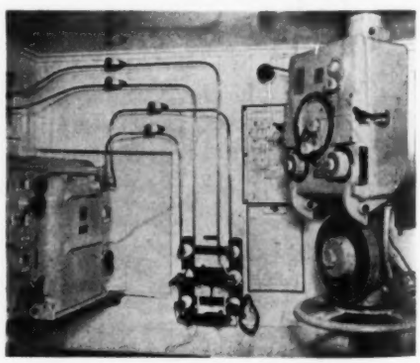
PROWLERS WHO VISITED the "Old Bentz Place" near Baraboo, Wis., received the surprise of their lives when a recently installed electronic inter-communicating device was successfully used against them.

The manager of the farm, which is owned by a Chicago business executive, had retired for the night when a car was heard turning in at the driveway. Peering through his bedroom window, the farmer saw a person climb out and head for a machine shed, while the driver turned the car around.

As the intruder reached to open the shed door a voice roared through the

• • •

DIRECTION FINDER LOCATES WHALES



The direction finding equipment used by German whalers to ascertain the true position of one of these huge mammals which has been tagged with a harpoon equipped with radio transmitter

Magnification x 10 brings out the uniformity and fine finish of this "Superior" product.

Here's One for Ripley . . .

There is no prize for the best guess so we will tell you now that in that little 3⅛" x 4" box pictured above there are 52,600 seamless cathode sleeves! A high-powered glass was necessary to bring out the fact that they actually are tubes—tubes with a diameter of .016" and a wall thickness of .002", each one a minute jewel of ultra-precision workmanship . . . We attach importance to this particular order only because it illustrates that whatever *your* requirements are in fine small tubing Superior believes it is capable of meeting them. Write us.

SUPERIOR TUBE COMPANY · NORRISTOWN, PA.

SUPERIOR PRODUCTS IN TUBING

SEAMLESS TYPE	*OTHER TYPES*
CARBON STEELS	*Welded or Brazed*
ALLOY STEELS AND TOOL STEELS	*and then Cold Drawn*
STAINLESS STEELS	
COPPER	BUTTWELDED STEEL
ALUMINUM	BRAZED STEEL
INCONEL	BRAWN MONEL
NICKEL	BRAWN INCONEL
MONEL	WELDRAWN STAINLESS

Largest American Producers of Pure Nickel Cathode Sleeves in Seamless and Lockseam

SUPERIOR TUBING

Television and Radio
During the past decade radio and television have made almost unbelievable progress, demanding better engineering materials and workmanship.
At the same time in ceramic insulation the quality and exactness of manufacture of AlSiMag has led the field.
Take advantage of this research by submitting your insulation problems to our engineers. The experience of thirty-seven years' continuous service is at your disposal.
AMERICAN LAVA CORPORATION Chattanooga, Tennessee
SALES OFFICES
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St. Louis
San Francisco
Los Angeles

darkness, seemingly coming from nowhere, but loud enough to be heard half a mile. Sternly the speaker ordered the would-be thieves to "beat it." Promptly, but unceremoniously, they obliged.

The "Teletalk" inter-communicating system with which the farm is equipped is claimed to be the only one of its kind to be found on an American farm anywhere. In his Chicago office the farm's owner uses an identical outfit for communicating with distant employees without leaving his desk. In the past year it has been widely adopted for similar use in offices, factories, garages and similar places.

The Baraboo farm system includes four outlets, one in the manager's house, another in the owner's residence close by, the third in the cowbarn and the fourth in the barn wall, facing the yard.

This inter-communicating system saves an amazing amount of time and footsteps, the owner reports. When a telephone call comes, the manager's wife locates him through the instrument without leaving the house. Speaking from the station in the cow barn, the manager can tell her his answer without walking to the house. He can also call his wife from the barn, if he happens to remember something to be done at the house. In bad weather the system is especially helpful in saving trips back and forth.

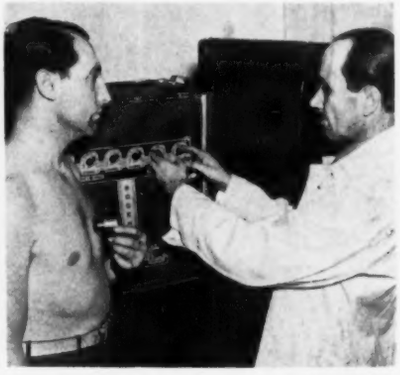
Shunt-Excited Antenna Used by U-h-f Station

By DONALD M. MILLER, KSTP

W9XUP, LOCATED at St. Paul, Minnesota, and operating on 26,150 kc is using a method of antenna coupling which is unique in ultra-high frequen-

• • •

ELECTRICAL STETHOSCOPE AIDS IN REGULATING HEART BEATS



An electrical stethoscope is being used by Dr. O. F. Pedroso, San Paulo, Brazil, in a demonstration of his method of voluntary regulation of heart beats. The loudspeaker of the cardiotachometer enables the audience to listen to the patient's heart beats as medical experiments are carried out by Dr. Pedroso

EASY FORMING . . .
SOUND SPOT WELDS

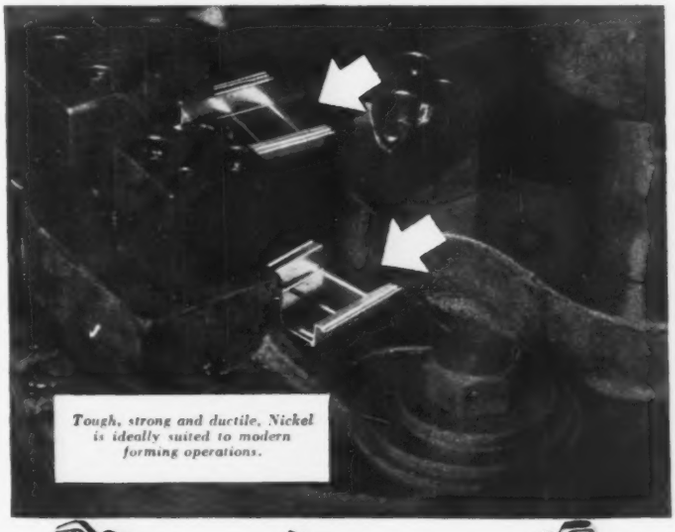
Nickel, first chosen for simple tubes of early days, withstands the rigors of modern fabrication

INTRICATE PARTS made of Nickel strip, wire and tubing—formed, drawn, bent, notched, peened, spot welded—are turned out by the million—*and each part precision made.* No wonder Radio relies upon Nickel: For just as this amazing metal answered the requirements of early pioneers, so today, in various forms and alloys, it meets the complex demands of modern tube production.

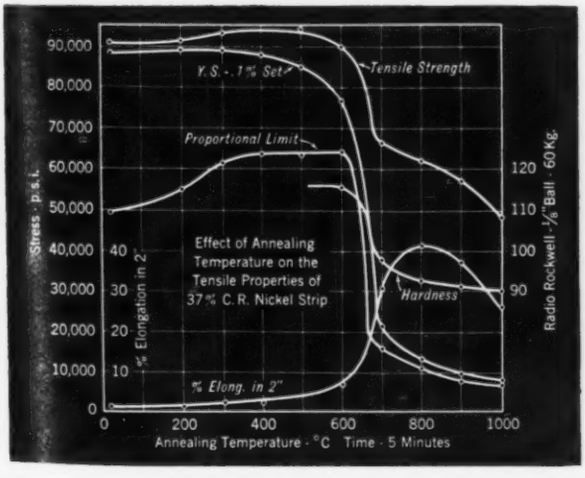
Strong and tough, yet ductile, Nickel has excellent fabricating qualities. It forms readily—avoids breakage under the rigors of the most intricate forming. It spot welds readily to Nickel and carbonized Nickel, and also to many other metals—producing a strong joint with little oxidation.

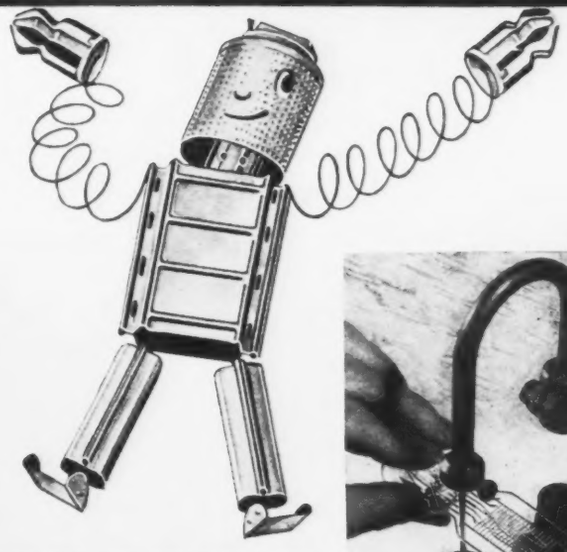
And despite the demand for smaller and smaller parts, closer and closer spacing and precision, all have been possible because of the superior fabricating qualities of Nickel. Not alone in tube factories, but in numerous plants making special wire, tubing and strip for radio parts, the excellent fabricating qualities of Nickel have simplified the job, increased yields, cut costs.

Perhaps they can do the same for you. We'll be glad to discuss your needs—and to mail your copy of "Nickel in the Radio Industry." Address "Electrical Research."



Tough, strong and ductile, Nickel is ideally suited to modern forming operations.





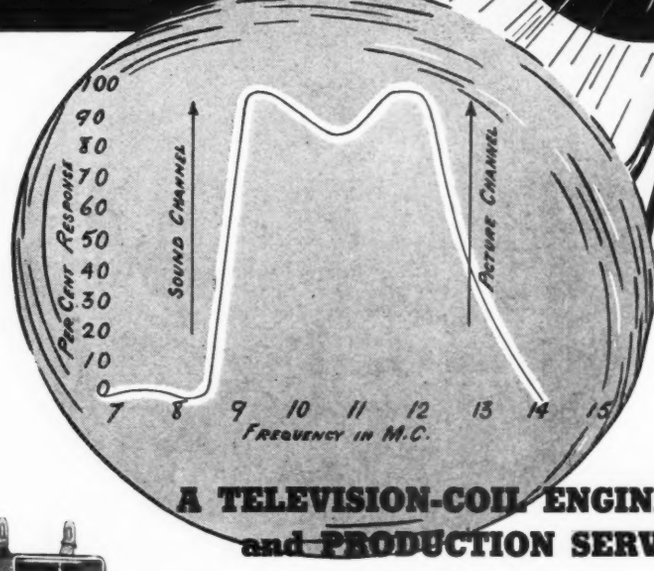
NICKEL

Nickel spot welds readily to many metals, producing a strong joint with little oxidation.

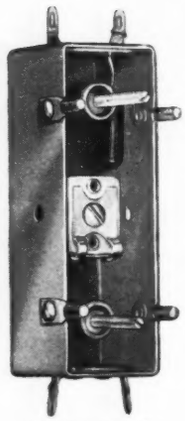
THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

SICKLES

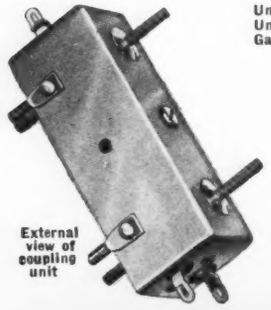
Announces...



A TELEVISION-COIL ENGINEERING and PRODUCTION SERVICE



Internal details of coupling unit



External view of coupling unit

● **Now available: Complete permeability-tuned I. F. transformers for both picture and sound channels. Transformers include wave traps necessary for preventing interference caused by both associated and adjacent channel sound carriers.**

PICTURE CHANNEL TRANSFORMERS

Unit Type 29—Wide Band Interstage Transformer*
Unit Type 47—Wide Band Interstage Transformer**
Unit Type 48—Wide Band Interstage Transformer**
Unit Type 40—Wide Band Diode Transformer
Unit Type 45—Sound and Picture Signal Separator

* Unit contains associated sound carrier trap.
** Unit contains adjacent channel sound carrier trap.

Gains of 3000 to 10,000 are possible, depending upon tube complement, with a useable band width of 3.85 MC. Wave traps give a rejection factor of 300 to 500 for associated sound carrier, and 600 to 1000 for adjacent channel sound carrier.

SOUND CHANNEL TRANSFORMERS

Unit Type 44L....Narrow-Band Interstage Transformer
Unit Type 44R....Narrow-Band Diode Transformer
Gain of 4000 to 5000 possible in sound I.F. Channel.

A typical performance curve is shown in the above cathode-ray pattern, illustrating the response of a Sickles picture I. F. amplifier for single-side-band transmission.

Submit Your Problem . . .

● **Our engineers are ready to collaborate in the development of your I. F. circuits for both sound and picture television reception. Production facilities second to none can meet your coil requirements and delivery schedules. ● Television engineering bulletin and prices sent on request.**

The F. W. SICKLES COMPANY
SPRINGFIELD, MASS.
DIAMOND WEAVE QUALITY F.W.S.CO.
MANUFACTURERS OF RADIO ELECTRICAL APPARATUS

cy-installations. It is essentially the same method that is used in many broadcast installations where a grounded antenna is used. This is called the Shunt Feed Method and has been adequately described by Morrison and Smith in a paper entitled "The Shunt Excited Antenna" which appeared in the June, 1937 issue of the Proceedings of the I.R.E. In the case of the W9XUP installation, however, the antenna is located at the top of a grounded 175 foot steel tower and the concentric transmission line runs up the side of the tower to the antenna. On top

Shunt-excited u-h-f antenna at W9XUP

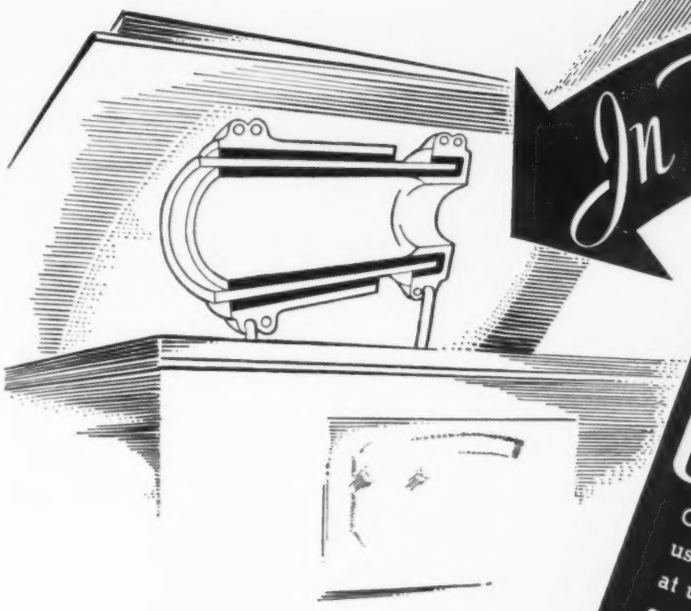
of the steel tower encased in a weather proof housing is the series condenser used for tuning the antenna. The lead from the condenser to the antenna is a semi-rigid conductor since the slant of this wire and its curvature are an important factor in tuning the system. The antenna proper is a three inch seamless steel tube $\frac{3}{4}$-wavelength long of which approximately $\frac{1}{2}$-wavelength is now being used as a radiator. It is mounted in a sleeve fastened to the tower so that the tube may be easily adjusted to any desired length up to $\frac{3}{4}$-wavelength. This method of tuning was used because of its flexibility, combining ease and accuracy of tuning. A steel platform four foot square has been constructed on top of the tower for use in the original installation and in the ensuing research on high frequency antenna design.

W9XUP is owned and operated by radio station KSTP and has been in operation since May 23, 1938. Originally the station operated on a frequency of 25,950 kc, but on December 20, 1938 the Federal Communications Commission granted the change to 26,150 kc due to interference with other stations on the same channel.

Simplified Calculations on Multi-Winding Transformers

By G. H. Browning
Browning Laboratories, Inc.

Some time ago the writer had occasion to calculate design data on an output transformer to feed three speakers. The problem was attacked and solved



In Television too—

it's CENTRALAB

Centralab Ceramic Capacitors find a definite use in Television because of their low loss at ultra high frequencies . . . because they can be supplied in a wide range of accurately controlled negative temperature coefficients, for circuit temperature compensation. The high quality ceramic insulation is unsurpassed for low power factor. Extreme accuracy is obtainable on rated capacity value and temperature coefficient.

A special bulletin showing engineering data is available on request. Specify Bulletin No. 630.

COMPENSATING CERAMIC CAPACITOR

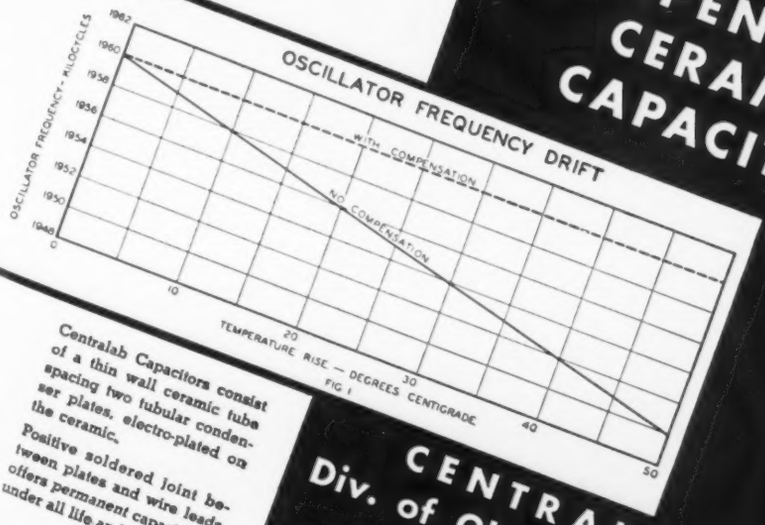
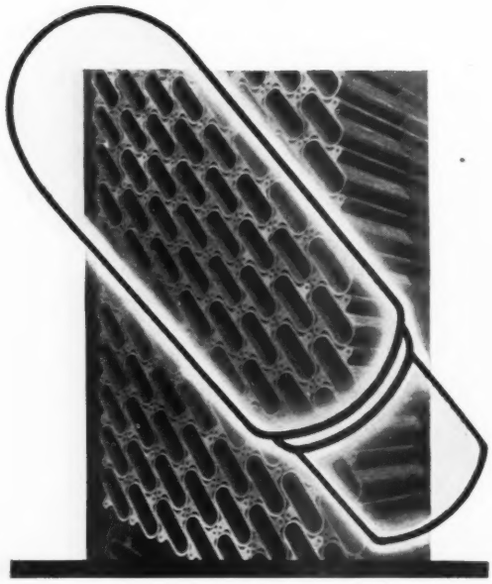


FIG. 1

Centralab Capacitors consist of a thin wall ceramic tube spacing two tubular condenser plates, electro-plated on the ceramic.

Positive soldered joint between plates and wire leads offers permanent capacitance under all life and aging tests.

CENTRALAB
Div. of Globe-Union Inc.
Milwaukee, Wis.



Only Graphite Anodes

are: VOLTAGE PROOF
HEAT PROOF
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Graphite Anodes, as supplied by SPEER CARBON COMPANY to leading tube manufacturers, have ALL these properties. No other anode material now in use has even one of them. For tubes with anodes you cannot damage by overloads . . . that will not fuse, blow out or soften . . . that cannot warp . . . that emit no gas and absorb gases given off by other tube elements . . . use tubes with SPEER Graphite Anodes. Why be satisfied with less? Write for Anode Booklet No. 70 and list of tube makers using SPEER Graphite Anodes.

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SPEER GRAPHITE ANODES

8869

by the conventional method which resulted in rather lengthy mathematical expressions before simplifications were made. In further considering the problem, it appeared that there should be some short cut which would be applicable to all cases. Such a simplified solution was found which requires no more assumptions concerning the transformer characteristics than are ordinarily assumed in the classical method. It is believed that many readers of *Electronics* have occasion to solve similar problems and will welcome a simple direct method of attack.

Let us first examine the problem of determining the reflected resistance in the case of a transformer with two secondary windings to which speakers or a resistance load will be connected, as shown in Fig. 1. In the case of speakers, there will be some motional impedance and leakage inductance but the phase angle is usually small and in many cases the speaker can be assumed to be a pure resistance. In an iron-cored perfect transformer, we know that

$$\frac{E_1}{E_2}=\frac{N_1}{N_2}=\sqrt{\frac{L_1}{L_2}} \quad \ldots\ldots (1)$$

$$\frac{E_1}{E_3}=\frac{N_1}{N_3}=\sqrt{\frac{L_1}{L_3}} \quad \ldots\ldots (2)$$

E_1, E_2, E_3 are the voltages across the respective windings, as shown in Fig. 1. N_1, N_2, N_3 are the number of turns on the respective windings. L_1, L_2, L_3 are the inductances of the windings.

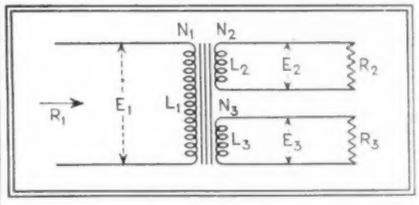

Fig. 1—Relationships between primary winding and two secondary windings, used in calculating power output in terms of load

The simplification of the problem is brought about by the justifiable assumption that the power fed to the primary will be equal to the sum of watts developed across the secondary loads.

Therefore

$$W_1=W_2+W_3 \quad \ldots\ldots (3)$$

where W_1 is the power in watts fed to the primary, while W_2 and W_3 are the power in watts developed in the respective loads R_2 and R_3. As the power in watts equals

$$W=\frac{E^2}{R} \quad \ldots\ldots (4)$$

Equation 3 may be written

$$\frac{E_1^2}{R_1}=\frac{E_2^2}{R_2}+\frac{E_3^2}{R_3} \quad \ldots\ldots (5)$$

Dividing through by E_1^2

$$\frac{1}{R_1}=\left(\frac{E_2}{E_1}\right)^2\frac{1}{R_2}+\left(\frac{E_3}{E_1}\right)^2\frac{1}{R_3} \quad \ldots\ldots (6)$$

Conquer Styling Problems

with Radio Cabinets of Bakelite Molded

The feminine daintiness of this Philco Transitone is emphasized by alternating intaglios and reliefs. Complete design, including all-around bevel, molded in one piece from ivory Bakelite Urea. Associated Attleboro Manufacturers, molder.

Portability is promoted in this Zenith Wavemagnet through the use of a light weight durable cabinet of brown Bakelite Molded. Entire cabinet, including louvre-like grill is molded in one operation. Chicago Molded Products Co., molder.

MANY OF YOUR problems of radio cabinet design and construction can be solved through adoption of Bakelite Plastics. Since the rich attractiveness of these versatile materials can be utilized for nearly any artistic conception of form and pattern, great freedom of styling is permitted.

This is evident in the two models illustrated. In the Philco-Transitone, harmonious balance of line and color has been achieved through the use of ivory-colored Bakelite Urea molding material. The graceful contours of the Zenith Wavemagnet are enhanced by the absence of angles and corners in its brown Bakelite Molded cabinet.

The finish of these cabinets is permanently lustrous; wiping with a damp cloth keeps it clean. The color goes all the way through; it will not wear off. And a full selection of colors is available . . . from white and ivory to midnight black . . . in transparent, translucent and opaque effects . . . in urea, cellulose-acetate, phenolic and polystyrene plastics.

Learn how you can conquer problems of design and construction through the use of Bakelite Molded and other Bakelite plastics. Write for Portfolio 13 of illustrated booklets describing many of these materials.

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At this single central source, more than 2,000 plastic materials are available, including molding materials, laminated stock and insulating varnishes of unusual value to radio designers. They offer wide selection of color, transparent or opaque effects, toughness, power factor and other characteristics.

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VISIT THE BAKELITE EXHIBIT, HALL OF INDUSTRIAL SCIENCE, NEW YORK WORLD'S FAIR, 1939

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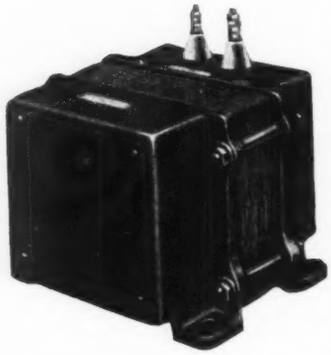
for Radio Transmitters

AmerTran Type "W" air-insulated plate transformer, a fully enclosed unit with all leads to bushings—Sizes to 7 Kva.

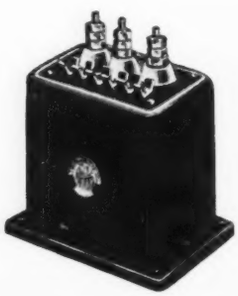


AmerTran Type "W" filter reactor with mounting similar to plate transformer—insulated up to 25 Kv. r.m.s. test.

Now AmerTran offers standard air-insulated transformer equipment of fully enclosed construction for practically every application in high-voltage rectifiers of the type used in broadcast transmitters and other equipment. In bulletin #14-5 (now available) nearly 600 items are listed, including plate transformers, input and filter reactors, filament transformers and voltage regulators — a rating to meet every need in both single- and three-phase rectifiers for output up to 14 Kw. at potentials from 1000 to 5000 volts. The bulletin also contains valuable circuit diagrams, filter attenuation curves, and rectifier operating data. May we mail you data on equipment suitable for your requirements? Send for bulletin #14-5.

AMERICAN TRANSFORMER COMPANY

178 Emmet St., Newark, N. J.



AmerTran Type "H" filament transformer—insulated up to 50 Kv. test.

AMERTRAN TRANSFORMERS

Manufactured Since 1901 at Newark, N. J.

Combining equations 1 and 6

$$\frac{1}{R_1}=\left(\frac{N_2}{N_1}\right)^2\frac{1}{R_2}+\left(\frac{N_3}{N_1}\right)^2\frac{1}{R_3}\quad\ldots\ldots(7)$$

Thus if the turns ratio of the transformer are known and the load resistances R_2 and R_3, the input resistance R_1 may readily be calculated by equation 7.

Now assume that it is desired to determine the turns ratio for a transformer to operate two speakers, the load resistances of which are known. The transformer must have the correct resistance to work out of a power tube or tubes. Thus R_1 is known. It is desired to deliver a given amount of power to each speaker, that is, W_2 and W_3 have a definite known value. Therefore, from Eq. 4, the voltages developed across the loads are readily calculated. Knowing E_2, E_3, R_1, R_2, and R_3, E_1 may be calculated from equation 5, and thus having E_1, E_2, and E_3, the turns ratio of the desired transformer may be determined from Eq. 1. To design the transformer, only the turns ratio is necessary as the actual number of turns on any winding is dependent upon the iron used, etc.

The method of attacking the problem of multiple winding iron cored transformers is perfectly general and may be used for any number of windings fed from either a single source or from a multitude of sources. In the case of the multiple sources, the phase relation of which is known, it is probably simplest to treat each source separately and then combine the voltages vectorially.

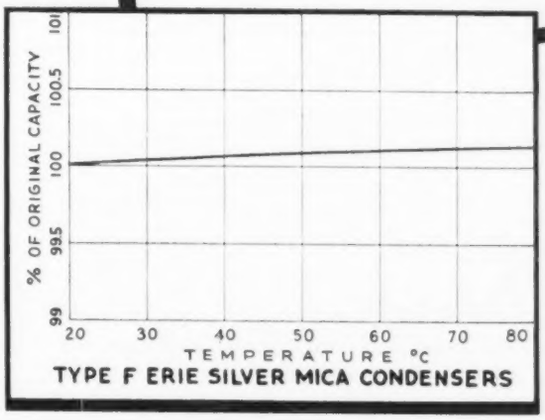
• • •

RADIO TRANSMITTER FOR AMBULANCES

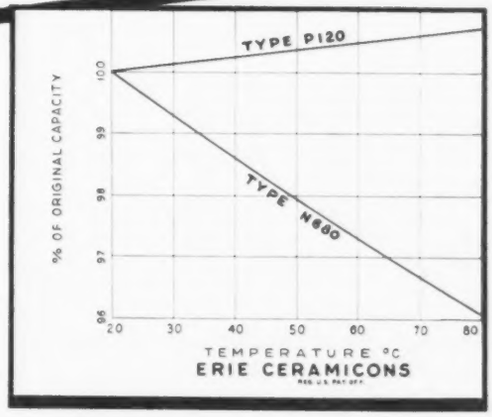
A portable radio transmitting and receiving set for use in an ambulance was recently displayed at the Royal Agricultural Hall in London. The equipment enables the driver to keep in touch with the hospital to which the patient is being taken

2 ways to obtain STABILITY

THAT IS INDISPENSABLE FOR AUTOMATIC TUNING



TYPE F ERIE SILVER MICA CONDENSERS



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❶ TO ELIMINATE DRIFT DUE TO CONDENSERS

Erie SILVER-MICAS

A dependable way to eliminate frequency variations produced only by unstable condensers is to use Erie Silver Mica Condenesrs. With a practically zero temperature coefficient (+.000025 per °C, or less) and with excellent characteristics throughout repeated cycles of heat and cold (—30° F to +175° F), these units will provide an ususually high degree of tuning stability.

❷ TO COMPENSATE FOR DRIFT OF OTHER COMPONENTS

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When undesirable reactance drift does occur in circuit elements other than the condenser, it must be compensated for to obtain tuning stability. Because Erie Ceramicons can be supplied with a stable and reproducible temperature coefficient between +.00012 per °C and —.00068 per °C, they will accurately compensate for any reactance change between these limits.

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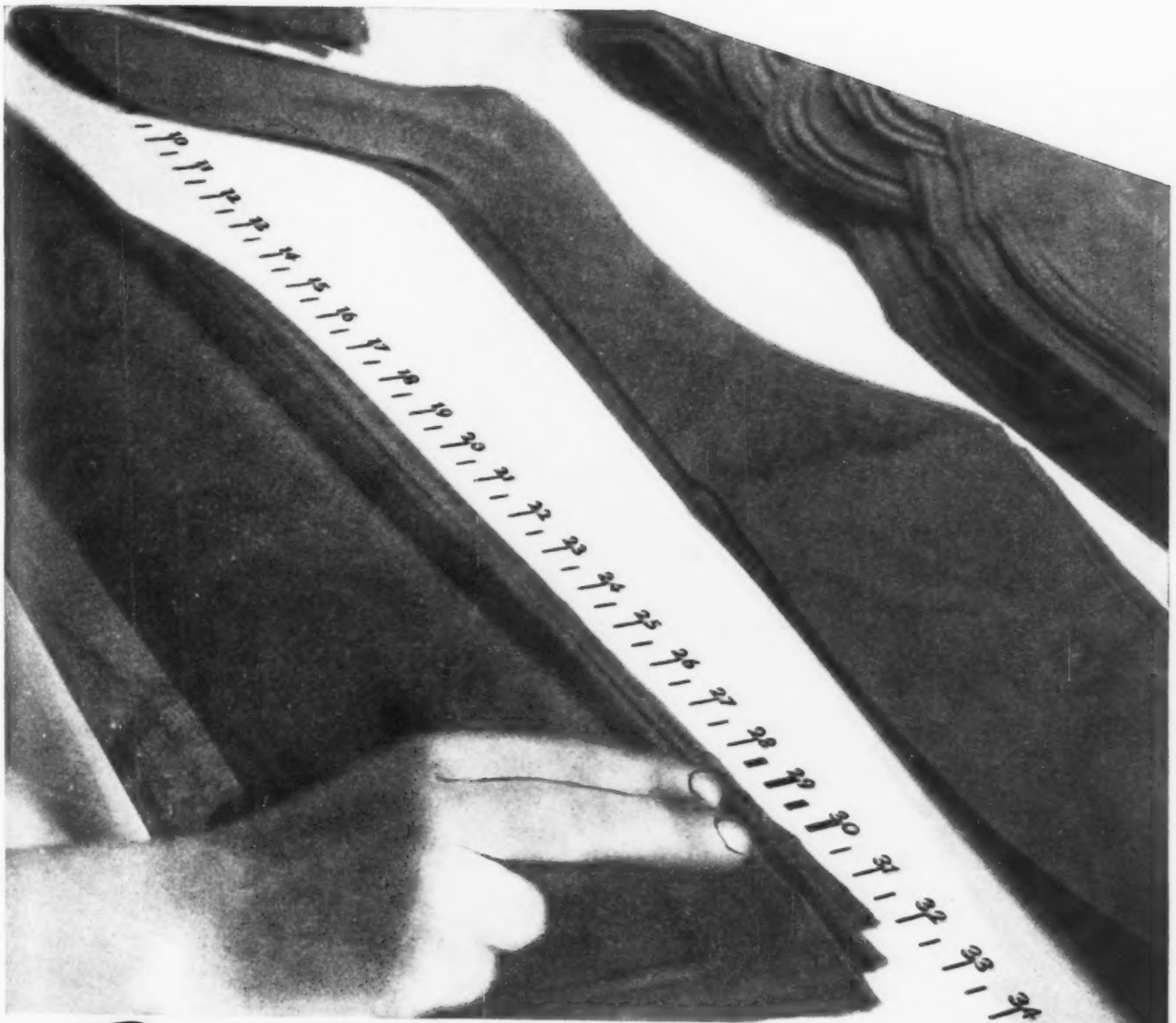

SCALES, INLAID IN FORMICA TABLE TOPS FOR INDUSTRIAL USES!

Formica table tops for industrial uses are made more useful by inlaying scales in the surface sheet of Formica for quick and accurate measurement of any thing that needs to be matched or graded. The picture shows such a table top in use in the Real Silk Hosiery Mills at Indianapolis for the inspection of silk hosiery.

The scale is always at hand. It is smooth and flat with no sharp corners or surfaces that can do injury to the product. It contributes to speed and reduces spoilage. The color may be white.

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FORMICA

THE ELECTRON ART

This month's review includes large screen television demonstration in London, use of secondary emission multipliers in noise-reducing circuits, frequency characteristics of oscillatory circuits, and review of amplifiers for television receivers

Survey of Present Television Developments

WITH TELEVISION service in the New York area already established by the end of April, considerable interest is being shown in brief survey articles in which the business and economic developments as well as the technical ones are reviewed. A number of these have already appeared, but the most recent which comes to our attention is "Television Now Ready for Public Participation" by W. R. G. Baker which appears in the April issue of the *General Electric Review*.

This two and one-half page article, by one who is very close to the field, briefly outlines the historical development of television, shows some of the present economic and technical problems to be solved, discusses program material, size of picture, cost of receiver and other information in which the average user would be interested, and concludes with a few short paragraphs on the future prospects of television. While this article contains nothing which is new to those who have followed the field closely, it can be recommended as a good, short survey for non-technical as well as technically inclined persons.

Big Screen Television

THE OCCASION of the Boon-Danahar prize fight in London recently was taken by Baird Television, Ltd., to demonstrate their big screen television equipment. During the past twelve months there have been many demonstrations of television pictures projected on to a screen 8 ft. x 6 ft. 6 ins., but this was the first time that a paying audience had seen anything larger.

Two movie theatres were used. In one was fitted a screen 15 ft. x 12 ft. and in the other a screen 12 ft. 6 ins. x 10 ft.

The method made use of specially developed cathode ray tubes. These tubes have a diameter of approximately 16 ins., but the intensely bright picture is built up on a fluorescent screen 5½ ins. x 4½ ins. They are fitted with a screen which is mounted inside in such a manner that its front face is scanned obliquely by the electron beam. Keystone distortion is corrected electrically and the resultant picture is front projected on to a silver surfaced screen that rises into position through a trapdoor in the stage.

The apparatus has now been left in position owing to the successful results of this demonstration and the projector for the larger screen is fitted with a 14 in. lens of $f/1.8$ aperture; whilst the smaller one is dealt with by a 10 in. lens of $f/1.6$ aperture.

Back projection is not used and the equipment is mounted in the center of the stalls, several feet away from the screen and below it. Everything is self contained and the operator has all the controls and meters to enable him to make any adjustments that may be required during the course of the actual transmission.

Each projector unit is of the twin type, that is to say, it has two cathode ray tubes which are kept running continously. One of these projects the picture on to the screen while the second acts as a standby, so that it can be brought into action immediately if failure should occur.

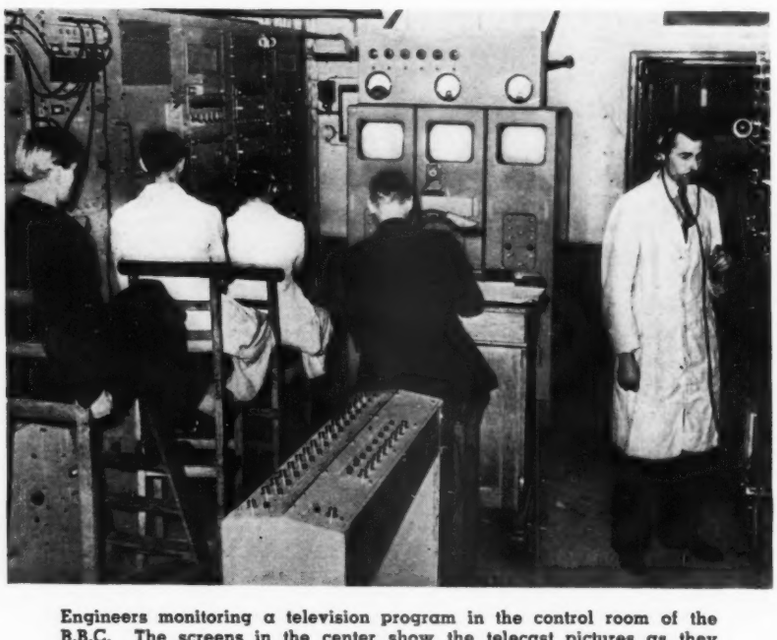
Apart from the power supply, all that is necessary is an aerial feeder connection from the standard television aerial on the roof of the theatre. Normally, the second anodes of the tubes have a voltage of between 40,000 and 45,000 volts applied, while the actual beam current is of the order of 300–400 microamperes. The source of the high voltage is a special power unit accommodated in another part of the theatre.

This unit comprises a voltage doubling circuit employing two valves and capable of giving a total output of 10 milliamperes at 60 kilovolts. Separate transformers are used to heat the valve filaments and these, together with the main high tension transformer and smoothing chokes, etc., are immersed in a tank of insulating oil. A ballast resistance connected across the output supply of the main transformer protects the winding against any damage, should a short circuit occur.

The whole of the equipment has been designed to comply with the requirements of the London County Council, regarding safety and the total power consumption is only about 2 kilowatts, drawn from public mains at 230 volts, 50 cycles.

The sound installation has an overall frequency response, from the aerial to loudspeaker, of plus and minus 4 decibels, between 30 and 20,000 cycles per second and the high-light brilliance of the projected pictures is equal to that of the usual movie film.

B.B.C. TELEVISION CONTROL ROOM



Engineers monitoring a television program in the control room of the B.B.C. The screens in the center show the telecast pictures as they are viewed by the televiewers. The cathode ray tube at the right is used for motion picture pick-ups. The operators at the left are monitoring the video channel, while the audio channel is under control of the operator at the right.

amplifier tube due to the shot effect of thermionic electrons.

The author shows that in amplifying photo-electric currents of a wide frequency range, using the ordinary phototube and amplifying circuit, useful limits of sensitivity are determined by a noise that arises in the load resistance of the phototube, during the process of transformation of signal current into signal voltage. From this it is concluded that a direct amplification of photoelectric current must be advantageous over conventional voltage amplification methods. The conventional phototube—amplifier circuit is then compared with the operations of a photoelectric multiplier circuit and it is concluded that the gain in useful sensitivity obtained with the photoelectric multiplier is practically 200.

Radio in Aviation

A PAPER READ before the Institute of Electrical Engineers, in London, on April 5, by N.F.S. Hecht, deals with, "Radio in Aviation; a General Survey with Special Reference to the Royal Air Force." This paper discusses conditions peculiar to the aircraft operations in respect to radio telegraphy and radio telephony. Particular stress is given to those conditions not usually met with in other applications of radio communication and particularly to the sources of interference to reception and of danger to aircraft and its occupants.

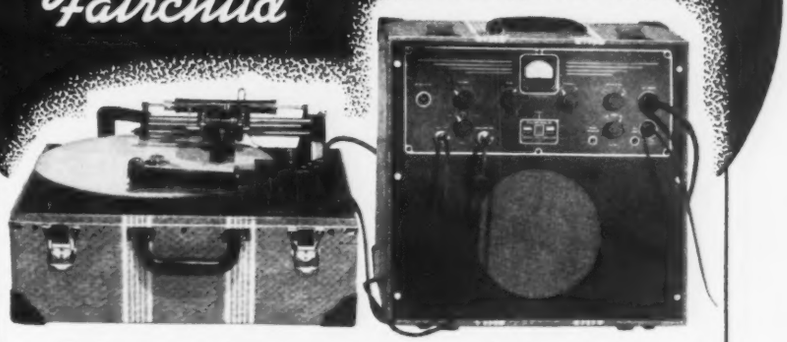
It concludes with a brief reference to a few special applications of radio and aviation, and while no attempt is made to describe the equipment itself the fundamental principles on which the construction is based are briefly given.

• • •

DEFOREST EXPERIMENTS WITH DIATHERMY

Dr. Lee DeForest has been spending his time recently in the development of diathermy and similar medical equipment using electron tubes. Here he is shown experimenting in the treatment of a sprained tendon in a show horse using equipment developed by the Lee DeForest Laboratories

Engineers you know will be glad to tell you about Fairchild



You're sure to know at least a few of the hundreds of engineers who use Fairchild F.26-2 Recorders. Just ask them to tell you about the results they achieve with this equipment. You'll find they're as proud of these fine precision instruments as we are.

For Fairchild sound recording equipment paces the industry. For example, the Fairchild F.26-2 Recorder has:

1. High gain amplifier to permit the use of a microphone without the necessity of a pre-amplifier.
2. Instantaneous change of speed from 33⅓ RPM to 78 RPM through push button control.
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5. Provision within the Recorder itself for variation of pitch and direction of cut. No expensive additional feed screws necessary.
6. Dynamically balanced 16 pound cast-iron turntable.

The Fairchild Recorder is a complete unit. It is instantly ready to record on any type of disc up to 17¼". With the exception of the microphone and stand, no additional purchases are necessary.

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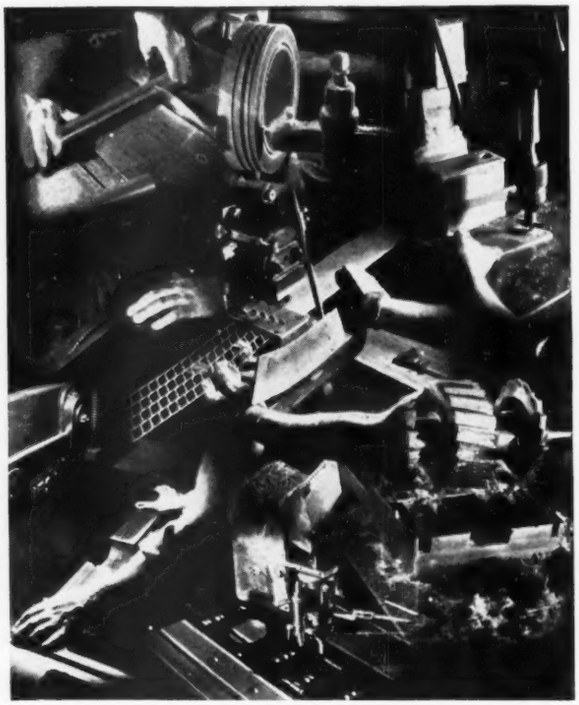

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PRESENT-DAY manufacturers know that Textolite laminated materials are outstanding in their adaptability to these fabricating processes. The dependable electrical and mechanical properties of this popular plastic material have been proved by years of successful operation of such integral parts as radio sockets, coil forms, test-tube racks, magnet cores, switch parts, and hundreds of others.

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For information write to either General Laminated office listed below or Section A59, Plastics Dept., General Electric, One Plastics Ave., Pittsfield, Mass.

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New York City
233 Spring St.

Chicago Ill.
3113 Carroll Ave.

GENERAL ELECTRIC

PD-51

Noise Reduction

IN AN ARTICLE in the April issue of "*The Wireless Engineer*," Dr. F. Dreisbach discusses the "Noise Reduction By Means of Photoelectric Multipliers." In this article it is pointed out that electron multipliers were introduced for the amplification of weak photoelectric signals because of the improved signal to noise ratio which these multipliers provide over circuits of equivalent operation using an ordinary photoelectric cell and vacuum tube amplifier. When secondary emission multipliers are used, the background noise can be considerably reduced compared with that arising in circuits employing phototubes and conventional amplifying circuits. It is the purpose of this article to determine the gain in sensitivity obtainable through the use of multipliers instead of the ordinary phototube and amplifiers under equivalent conditions.

The basic assumption underlying the theoretical work of this article is that a comparison is made between phototubes (and their required amplifiers) as compared with multipliers having the same light sensitivity. In this paper it is assumed that current amplification is employed only for the purpose of reducing background noise. Therefore, the electron multipliers need not have an amplification factor greater than 10,000.

The author considers three sources of noise as follows: (1) noise of the phototube, due to shot effect of the photoelectrons; (2) Johnson noise due to the effect of the resistor coupling the phototube with the grid circuit of the amplifying tube, and (3) noise of the first

• • •

DANCE OF ELECTRONS

From the research Laboratories of the General Electric Co. comes this photograph of a trace on a cathode ray tube screen. The trace, which greatly resembles the familiar G-E monogram in the circle was obtained accidentally, but maintained until permanent photographic record could be made. Bell-Lab makes a machine which speaks for itself; G-E produces a device that writes. By next month we should have heard from Westinghouse and RCA.

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CAPACITANCE C

RESISTANCE R

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Over 335 million RCA radio tubes have been purchased by radio users . . . in tubes, as in radio sets, it pays to go RCA All The Way.

WIDE RANGE OF MEASUREMENTS

The RCA Universal AC Bridge measures

Inductance . . . 10 microhenries to 10 henries

Capacity . . . 10 micro-microfarads to 10 microfarads

Resistance . . . 1 ohm to 1 megohm

Accuracy . . . 5% over all at full scale

Extremely portable, weighs only 5 1/2 lbs . . . Stock No. 9600 - $49.65 Net.

RCA Test Equipment

RCA Manufacturing Co., Inc., Camden, N. J.
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oscillatory type. In the latter case the diagram shows clearly how the characteristic curve for the resonance response

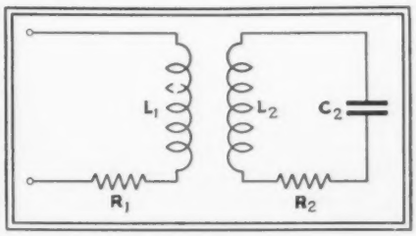

Fig. 1—Circle diagram for oscillatory circuits

Fig. 2—Tuned transformer for which equations are derived

of a parallel circuit is at its high-point double the value of the high-points of the coupled-oscillatory circuits' resonance curves.

A final construction shows how to obtain various types of band-filter characteristic curves by means of various methods of coupling.

High Frequency Tubes

A VERY BRIEF description, with photograph of a new high frequency tube developed by the Bell Telephone Laboratories, is given in the April issue of the *Bell Laboratories Record*. This tube, suitable for operation a frequency ranges between 30 and 300 megacycles has a plate dissipation of 50 watts and when used as an oscillator will deliver 75 watts. The tube is mounted entirely on a glass envelope without the base in the usual sense of the word.

• • •

M.I.T. X-RAY GENERATOR

Dr. John G. Trump and his compact direct-current electrostatic generator which produces a potential of 1,250,000 volts for the production of short wave X-ray. The equipment has been designed by Dr. Trump and Dr. Robert J. Van de Graaff, both of M.I.T.'s physics department. The high voltage generator is nine feet high and three feet in diameter and encloses the X-ray tube which is supported by the high voltage dome on which Dr. Trump has his hand

Television!

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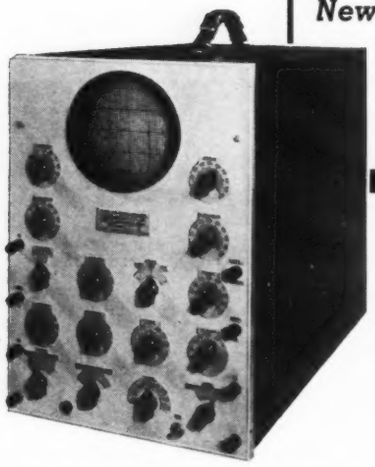

• There is now available, for the first time, a low-cost cathode-ray oscillograph incorporating many important features heretofore found only in larger, more expensive, and less portable instruments.

The Du Mont Type 175 Cathode-Ray Oscillograph incorporates the most recent advances in cathode-ray oscillography. Ideal for laboratory, shop, and field uses, it represents an important addition to the Du Mont line of cathode-ray indicating equipment for all purposes.

• Low cost and extended operating range are made possible by use of the intensifier-type cathode-ray tube. • It is available as the Type 175 for study of high- and low-frequency recurrent phenomena, and as Type 175-A including single-sweep control of horizontal deflection. • The amplifier frequency-range extends from 5 to 100,000 sinusiodal cycles per second. • Conveniently located short-lead terminals permit direct connection to the deflection plates for high-frequency and direct-current studies.

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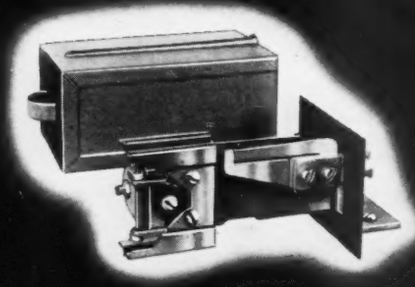

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Frequency Characteristic of Oscillatory Circuits

THE METHODS used in the development of "Graphic Methods for Determining the Frequency Characteristics of Oscillatory Circuits," by Friedrich Benz from the September, 1938 issue of *Hochfrequenz-technik und Elektroakustik* are based on the Heyland circle diagram. Starting from fundamental relations existing in the simple voltage and current resonant circuits, the author shows how the equation derived from this development, is

$$|Z_i| = \frac{R_{res.}}{\sqrt{1+\left(\frac{\Delta\omega}{\delta}\right)^2}}$$

where $\Delta\omega$ is the decoupling and δ is the damping factor, $|Z_i|$ is the absolute value of the overall impedance, is utilized.

The phase angle is determined from $\tan\phi = \frac{\Delta\omega}{\delta}$. Using these relations a simple circle diagram is constructed as in Fig. 1.

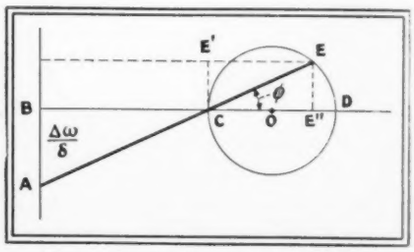


Fig. 1—Circle diagrams for oscillatory circuits

In the triangle ABC, AC is equal to $\sqrt{1+\left(\frac{\Delta\omega}{\delta}\right)^2}$ BC is 1 and AB is $\frac{\Delta\omega}{\delta}$ Lengthening the abscissa BC so that CD is 1 and drawing a circle with this value of CD as diameter then extending AC to point E will give for the portion CE the value, $\frac{1}{\sqrt{1+\left(\frac{\Delta\omega}{\delta}\right)^2}}$. Multiplying this by R_{res} will yield the absolute value of the impedance EE" which is of course the reactive component and EE' the active component.

The resonance-transformer circuit of Fig. 2 is treated in similar fashion and a graphical construction for its impedance is developed. The author gives the general equation for its impedance as

$$Z = R_1 + j\omega L_1\frac{k^2}{u^2}\left[\frac{\omega^2 L_2^2 R_2}{R_2^2+\left(\omega L_2-\frac{1}{\omega C_2}\right)^2} + j\,\frac{\omega^2 L_2^2\left(\frac{1}{\omega C_2}-\omega L_2\right)}{R_2^2+\left(\omega L_2-\frac{1}{\omega C_2}\right)^2}\right]$$

where u is given by $(L_2/L_1)^{\frac{1}{2}}$ and k is the coupling factor.

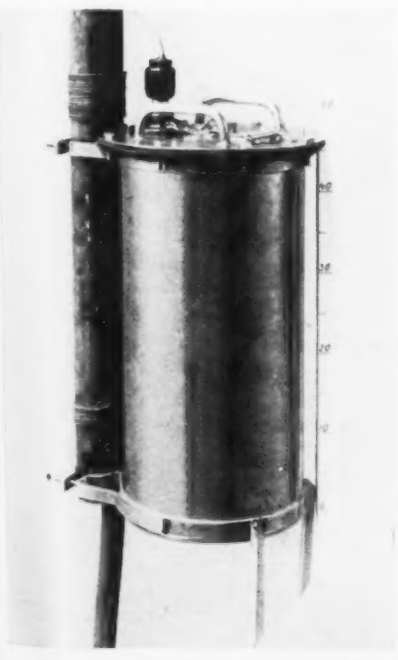
The author follows this with a graphical development of the relations for the coupled-oscillatory circuit, and the parallel-resonant circuit of the coupled-

Amplifiers and Television Receivers

AN ARTICLE by M. J. O. Strutt in the April issue of *The Wireless Engineer* deals with "High Frequency, Mixing and Deflection Stages of Television Receivers."

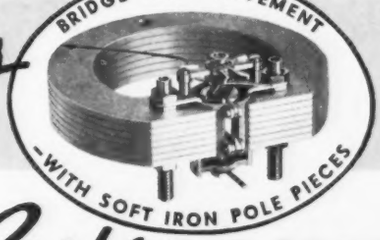
Based on work conducted at the Physics Laboratory of the N. B. Philips' Gloelampenfabrieken, at Eindhoven, the author shows that the input voltage of television signals should be at least one or two millivolts in order that the signals may be satisfactorily above the noise level. These requirements entail a total gain from the antenna to the second detector of approximately 5,000. A description is given of several types of radio receivers for television purposes, and the general arrangement of the amplifying stages receivers is discussed. A receiver is described using three radio frequency amplifiers in which three different types of tubes are employed. The performance of the experimental receiver and a study of the condition which tubes in television receivers should satisfy is given. A superheterodyne television receiver using experimental tubes is described. The conditions imposed upon a diode which is used as a second detector in a television receiver, are described, and a new diode, favorable for this purpose, is described.

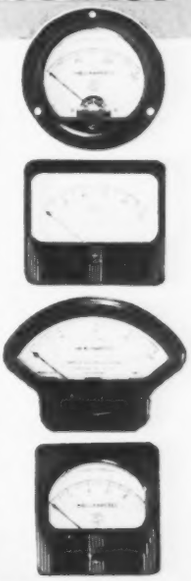
GERMAN WHALERS USE RADIO TO LOCATE CATCH



This tiny transmitter is used by German whalers to aid in locating their catch. The transmitter is attached to the harpoon, as shown, and emits a signal for several hours. The whale thus tagged need not be killed immediately, but can roam about until the crew on the mother ship can take it aboard

This BRIDGE TYPE MOVEMENT —WITH SOFT IRON POLE PIECES LASTING ACCURACY Costs NO MORE!





Use SIMPSON Testing Instruments

Model 202

• The finer Simpson movement is also the basis of a complete line of Testing Instruments. The Model 202 Roto-Ranger Volt-Ohm-Milliammeter with twelve automatically changing independent scales is illustrated above. Opposite is shown the Model 230 — smallest pocket-type Volt-Ohm-Milliammeter. Ask for description of full line of testers.

Model 230

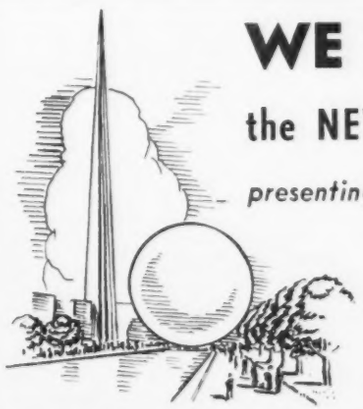
SIMPSON instruments have a fighting heart — a movement with the expensive bridge-type construction and soft iron pole pieces. But thanks to modern production methods you are not asked to pay a premium price for this premium feature.

Manufacturers who build quality equipment have naturally selected these finer, more attractive instruments as the finishing touch to their product. Typical instruments are illustrated. Ask for bulletins describing ten models covering every requirement. Let us show you why so many leading manufacturers have adopted Simpson instruments.

SIMPSON ELECTRIC COMPANY
5212 Kinzie Street, Chicago, Ill.

SIMPSON
INSTRUMENTS THAT STAY ACCURATE

WE SALUTE
the NEW YORK WORLD'S FAIR
presenting the World of "TOMORROW"



GOAT *form fitting*
TUBE SHIELDS
. . . serving "Tomorrow's" electronic needs

GOAT RADIO TUBE PARTS
GOAT RADIO TUBE PARTS, INC.
(A DIVISION OF THE FRED GOAT CO., EST. 1893)
314 DEAN ST., BROOKLYN, N. Y.

All Set for TELEVISION

CONTROLS . . .

● **CLAROSTAT television controls are geared to critical requirements of video reception. Composition-element type for high resistance values (1000 ohms to 5 megohms); wire-wound type for lower values (1 to 100,000 ohms.). Either type provided with insulating sleeve of 2000 or 5000 v. insulation to ground. Meet Underwriters' test at stated voltages.**

RESISTORS . . .

● **CLAROSTAT power resistors have gained widespread acceptance particularly among builders of dependable equipment. These familiar green cement-coated resistors are to be found in television transmitters, receiver power supplies, oscillographs, etc. Comparative tests invited. In 10 to 200 watt ratings; any resistance; fixed, tapped and adjustable. Competitively priced.**

Submit that Problem . . .

2 THINGS too good to miss
★ The 1939 National Radio Parts Trade Show
★ Our Display at the Show

Tell us of your resistance requirements. Engineering aid, specs., quotations, samples, cheerfully supplied.

Look us up at Booth 620-22 Hertz Ave., in June.

CLAROSTAT
MANUFACTURING CO. Incorporated
285 North Sixth St. Brooklyn, N. Y.

Electrolytic Condensers

AN ARTICLE under the above title, was read by Phillip R. Coursey before the Institution of Electrical Engineers in London, on February 1.

The paper deals with the development of the electrolytic condenser which is now so widely used in modern radio receivers and in amplifying apparatus.

A brief pictorial survey is given to indicate the lines of development which have led up to the modern design. This is followed by the description of the construction and chief electrical properties of the various types of condensers which are now used. The properties influence to a very great extent the manner in which the condenser can most economically and usefully be employed.

Various theories have been put forward to explain the action of the electrolytic condensers, but some of these do not now appear to be adequate. A critical summary is given with an expression of the views as to the most likely explanation.

The manufacturing methods are treated at some length, together with the considerations which influence the employment of these condensers.

Practical Application—A standardized method of test is recommended to secure uniformity in assessing their properties.

This paper will undoubtedly appear in a forthcoming issue of the Journal of the Institution of Electrical Engineers.

• • •

SPEED OF LIGHT MEASURED AUTOMATICALLY

Dr. Wilmer C. Anderson, research fellow at Harvard University, shown with his equipment for measuring the velocity of light. An interesting development of this equipment is that no visual observations will be required; the entire system is completely automatic in operation. It is expected that the speed of light can be measured by this system with an error of only 2½ miles per second, a precision of 1 part in 75,000

NA-ALD
TELEVISION
Components

WRITE FOR THE LATEST DATA ON A WHOLE SERIES OF NEW NA-ALD TELEVISION COMPONENTS.

● **They are developed in collaboration with laboratories that have had the benefit of observing actual requirements revealed in field tests.**

● **In part, they consist of a connector for the 11-prong Cathode Ray tube—1802-P1 and 1802-P4.**

● **The development not only consists of meeting every requirement in the connector, but also in the attached leads. Special material and processes meet high voltage breakdown tests. (Underwriters double voltage + 1000.) Has complete freedom of *ionization noises* at operating voltages with tests at both normal and extreme humidities.**

● **Other components—special rectifier socket — low capacitance sockets and plugs—interlocks—high Q wire—safety grounding cords—insulated tube caps, etc.**

Write us just what you are doing in television so that we may keep you informed of developments that will interest you.

NA-ALD
ALDEN PRODUCTS COMPANY
717 Center St. Brockton, Mass.

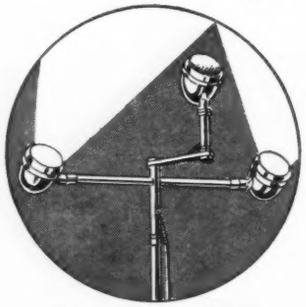
"TOPHET" Resistance Wire is to the Electric Heating Appliance what the Trylon-Perisphere is to the World's Fair.

Visit our exhibit at the World's Fair, in the Metals Building opposite the Trylon.

WILBUR B. DRIVER CO.
NEWARK, NEW JERSEY

It's GRAND For BANDS

New MULTI-UNIT Crystal Microphones provide maximum amplification and cannot be acoustically overloaded. Performance, flexibility and beauty all combined. List price, MU-2 complete, $29.50



New MIKE-LITE Gives Great Delight

This includes Model T-3 Crystal Microphone with two adjustable spotlights that throw a flattering halo of soft, warm light on entertaining artists and speakers. Complete, as described, with stand, transformer and cable. List Price $62.50

We'll Be Seein' You

Astatic's complete line of quality crystal microphones and pickups will be on display at the Show. Don't miss this important exhibit.

ASTATIC MICROPHONE LABORATORY, Inc.
YOUNGSTOWN, OHIO
Licensed Under Brush Development Co. Patents
Astatic Patents Pending

TELEVISION COMPONENTS

(*Continued from page 22*)

Several specialized trimmer capacitances have appeared for trimming the u-h-f oscillator, for example a Cardwell 10 $\mu\mu$f unit with an extended shaft, but these differ little from the standard midget variable capacitors.

The problem of adjusting the gain of video frequency amplifiers has occupied the attention of the volume control manufacturers. International Resistance, Clarostat, and Stackpole have special volume controls with very low stray capacitance from the center arm to ground. The terminal of the contact arm is taken out through the "back" of the control, and an insulated shaft can be used to reduce the capacitance still further. Otherwise the controls are similar to the standard units.

TABLE II
Television Amplifiers and Rectifiers

Pentodes

Type	g_m μmhos	C_{gk} $\mu\mu$f	C_{pk} $\mu\mu$f	C_{pg} $\mu\mu$f	g_m/C	μ
1851	9000	11.5	5.2	0.02	507	6750
1852	9000	11.0	5.0	0.015	530	6750
1853	5000	8.0	5.0	0.015	385	3500
1231	5500					3850

Rectifiers

Type	Filament volts, amps	Plate ma	R-m-s a-c volts	Peak inverse volts
878	2.5,5.0	5	7100	20,000
879	2.5,1.75	7.5	2650	7500
2V3G	2.5,5.0	2	5500	16,500
2Y2	2.5,1.75	5	4400	12,000

Wire and Cable; Antennas

High quality hook-up wire, especially for high voltage circuits, has been made available by Alden Products, Cornish Wire, and Lenz Electric. Low-loss coaxial cable, suitable for extended video-frequency circuits, or for lead-ins for antennas is offered by Alden Products, American Phenolic Co., Lenz Electric, The Transducer Corp. and The Telegraph Construction Co. (Charles Parrag and Co. American representative). Di-pole antenna assemblies are available from Brach, Radiart, and Technical Appliance Corp.

Picture I-f and Power Transformers

Late returns from the questionaire reveal that E. I. Guthman and Co. have available two types of permeability-tuned i-f transformers for the picture channel, which tune from 10 to 13 Mc and which are available with or without wavetrap circuits. The units are mounted in aluminum cans and tune from one side. The Thordarson Company has four television transformers: a 3000-volt unit for type 1801 tubes, a 6000 unit for type 1800 tubes, a 2.5-volt heater transformer for either 1800 or 1801, and a horizontal scanning output transformer for magnetic deflection.—D.G.F.

TABLE I
Television Cathode-Ray Tubes

Type Number	Screen Color	Length (inches)	Diameter (inches)	Heater Rating (volts, amps.)	Type of Deflection	Second Anode (volts maximum,	Manufacturer
1800	Yellow	21	9 1/8	2.5,2.1	Magnetic	7000	NU,RCA
1801	Yellow	15 3/4	5 1/16	2.5,2.1	Magnetic	3000	NU,RCA
1802-P1	Green	16 3/4	5 3/16	6.3,0.6	Electric	2000	HS,NU,RCA
1802-P4	White	16 3/4	5 3/16	6.3,0.6	Electric	2000	HS,NU,RCA
1803-P4	White	25	12 3/16	2.5,2.1	Magnetic	7000	NU,RCA
1804-P4	White	21	9 1/8	2.5,2.1	Magnetic	7000	NU,RCA
1805-P4	White	12	5 1/16	6.3,0.6	Electric	2000	NU
906-P1 P4	P1 Green P4 White	11 7/8	3 1/16	2.5,2.1	Electric	1500	HS,NU,RCA
2002	Green	7 1/16	2	6.3,0.6	Electric	600	NU
2005	Green	16 3/4	5 1/16	2.5,2.1	Electric	2000	NU
54-11-T	White	16 3/4	5 3/16	6.3,0.6	Electric	2000-4000*	DuM
94-11-T	White	21	9W	6.3,0.6	Electric	5000-10,000*	DuM
144-11-T	White	21 1/4	13 1/2	2.5,2.1	Electric	6000	DuM
34-7-T	White	11 15/32	3	2.5,2.1	Electric	1500	DuM

* High voltage rating applies to " intensifier " electrode near luminescent screen.

THE INDUSTRY IN REVIEW

High Speed Four Column Facsimile Recorder

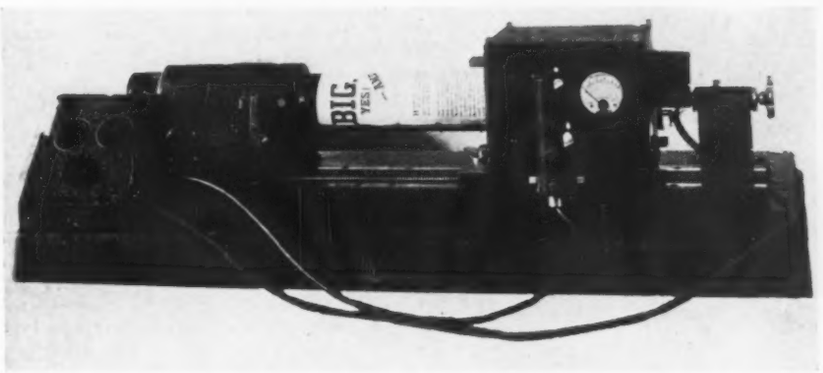
FOR several years facsimile transmission has been in commercial use in point-to-point service by radio and by wire; and there has been a continuing hope that adaptation of facsimile apparatus for use in the home would be a natural extension of the general idea of transmitting information, in facsimile. For quite some time experimental transmissions from certain broadcast stations, and from transmitters operating on the higher frequencies, have been made with the object of discovering the possibilities and the troubles with home facsimile.

A recent development of a high speed recorder utilizing a wider strip of recording paper, made by the Finch Telecommunications Laboratories has made more attractive the possibilities of transmissions by radio to the home. Finch transmitters and receivers are being actively tested by 13 broadcast stations under experimental conditions.

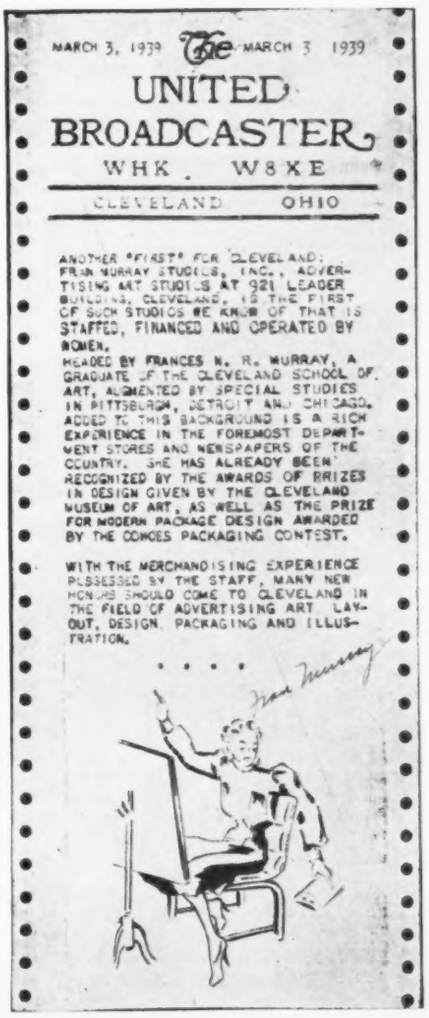
The new recorder shown in the illustration, employs an endless chain upon which are mounted three pens or styli at regular intervals. The chain travels continuously in one direction and at the same time, the platen, carrying the full width paper (8.5 inches wide) upon which the image is to be reproduced, rotates. As one stylus passes off the paper, a second commences its line at the left and as this one travels off at the right, a third stylus or pen is caused to begin the next line. When this stylus has passed across the paper, No. 1 is again ready to start.

This new design simplifies the mechanism greatly as a reciprocal motion is not needed, a continuous or linear motion taking its place. The same basic principles, such as synchronizing pulse and other features as employed in the 2 column unit are incorporated in this new high speed four column unit.

The Finch recorder (which operates from a drum scanner) will deliver 18.36 sq. in. of perfect copy a minute using the standard 8.5 inch width paper thereby operating the paper speed at approximately 10 feet of paper per hour. Assuming that 10 point type is used throughout the useful field of the 8.5 inches of paper there will be between 9050 and 9100 words transmitted each hour. This means that the system is capable of transmitting and receiving copy at a speed of close to 135 words per minute. This speed also is maintained in the transmission of photographs, maps, drawings, sketches and other intelligence data.



Above, the new continuous-scanning Finch facsimile transmitter. The corresponding receiver employs three styli on an endless belt. At the left, below, is a typical sample of facsimile sent from WHK-W8XE



MARCH 3, 1939 The MARCH 3 1939

UNITED BROADCASTER

WHK . W8XE

CLEVELAND OHIO

ANOTHER "FIRST" FOR CLEVELAND: FRAN MURRAY STUDIOS, INC., ADVERTISING ART STUDIOS AT 921 LEADER BUILDING, CLEVELAND, IS THE FIRST OF SUCH STUDIOS WE KNOW OF THAT IS STAFFED, FINANCED AND OPERATED BY WOMEN.

HEADED BY FRANCES N. R. MURRAY, A GRADUATE OF THE CLEVELAND SCHOOL OF ART, AUGMENTED BY SPECIAL STUDIES IN PITTSBURGH, DETROIT AND CHICAGO. ADDED TO THIS BACKGROUND IS A RICH EXPERIENCE IN THE FOREMOST DEPARTMENT STORES AND NEWSPAPERS OF THE COUNTRY. SHE HAS ALREADY BEEN RECOGNIZED BY THE AWARDS OF PRIZES IN DESIGN GIVEN BY THE CLEVELAND MUSEUM OF ART, AS WELL AS THE PRIZE FOR MODERN PACKAGE DESIGN AWARDED BY THE CONDES PACKAGING CONTEST.

WITH THE MERCHANDISING EXPERIENCE POSSESSED BY THE STAFF, MANY NEW HONORS SHOULD COME TO CLEVELAND IN THE FIELD OF ADVERTISING ART. LAYOUT, DESIGN, PACKAGING AND ILLUSTRATION.

In the Finch facsimile system synchronization is effected by two simple control units. One is a small electromagnetic governor attached to the motor that drives the home recording machine in such a manner that it holds its speed at a constant value. The other is a sensitive electro-magnet clutch. This is operated by what is termed a "selective synchronizing pulse"—a low-tone radio signal of extremely short duration which is sent over the air and starts the recording machine at exactly the right time. This pulse also keeps the receiving machine in exact step with the transmitter throughout the printing period and stops the machine.

Facsimile Chain

Much interest has been shown, recently, in the "chain" broadcasting of facsimile material through WOR, WGN, WHK, and WLW. These stations have formed what is believed to be the first facsimile network; and may give further indication of the possibilities of such transmissions for general usage.

(*Continued on page* 62)

AC-Operated

Heterodyne Sound Analyzer

RA-277

Sound Frequency Analyzer

- Accuracy and detail in noise analysis insured by use of Bell Telephone Laboratories lattice crystal filters in heterodyne circuit.
- Calibration stability maintained by feedback circuits and moving coil microphone.
- New, large, open-scaled indicating meter is easy to read.
- Can be used with high-speed recorder for analysis by the sweep method.
- Also makes overall sound level measurements in accordance with A.S.A. standards.

Laboratory Acoustic Instruments
●
Production Test Equipment
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Testing and Consulting Service

Electrical Research Products Inc.
SUBSIDIARY OF
Western Electric Company
195 BROADWAY, NEW YORK

Now in Press

ZWORYKIN and MORTON'S

TELEVISION

The Electronics of Image Transmission

By V. K. ZWORYKIN and G. A. MORTON
RCA Manufacturing Company

This long-awaited book is now in press and will be published in the near future. It is written from the engineering viewpoint. The first part of the book is devoted to a consideration of the fundamental physical phenomena involved in television; namely, emission of electrons, including photoelectric and secondary emission; fluorescence; electron optics; and vacuum technique. This is followed by a discussion of the fundamentals, treating the relationship between the physical system and such picture qualities as brightness, contrast, flicker and resolution. The principles of the ultra high-frequency transmission and reception of television signals, single sideband operation and the more important methods of pickup and reproduction of images are included in this section. The third part takes up the details of an electronic television system, treating in turn the Iconoscope, Kinescope, electron gun, video amplifier, scanning and synchronization, the complete transmitter and receiver. A description of a working system as exemplified by the equipment used in the RCA Television Project constitutes the concluding part of the book. Coming from such an authoritative source, this book warrants the attention of all interested in television.

Approximately 560 pages 6 by 9 Probable price, $6.00

MAKE YOUR RESERVATION NOW

JOHN WILEY & SONS, INC., 440 Fourth Ave., N. Y.

Industry in Review

(Continued from page 61)

Constants of Finch Facsimile High Speed Commercial Model (type FC)

Number of lines per min	130
Total Length of stroke	9 in.
Number of lines per inch	60
Width of paper on recorder	8.5 in.
Length of paper on recorder	500 ft.
Maximum Width of useful copy	8.5 in.
Number of feet per hour	10 ft.
Width of paper on scanner drum	8.5 in.
Length of paper on scanner drum	17 in.

News

✦Dr. E. F. Lowry, formerly with Westinghouse E&M Co, and recently with Continental Electric Co. has joined the St. Charles Technical Labs, Inc., of St. Charles, Ill., taking charge of their hot cathode development. . . . Oxford-Tartak Radio Corp., Chicago, have announced a "sensational" new speaker. The overall size of this unit is 2.5 ins., smaller than a package of cigarettes . . . Tobe Deutschmann, Canton, Mass., has completed an electrical transcription of the various types of radio interference and will make the records available to the radio trade so that dealers and service men may identify noise and demonstrate to customers that most noises heard in modern receivers have an electrical origin and are not the result of trouble in the set.

Literature

Electro-Dynamic Unit. Described in bulletin No. U-300. Permanent Magnet Speaker is described in bulletin No. 70. Literature is also available on Utility Line and Four Throat Aircraft Horns. Fox Sound Equipment Corp., 3120 Monroe St., Toledo, Ohio.

Engineering Properties of Monel. Technical information on mechanical properties is contained in Bulletin T-5. International Nickel Co., Inc., 67 Wall Street, New York City.

Did YOU Ever SEE a 1/1000 AMP. FUSE

Now From Littelfuse Comes the "World's Smallest!"

It took over three years of research and development work to produce this new 1/1000 amp. vacuum enclosed VIDEO LITTELFUSE. It is the most sensitive and has the *lowest* rated capacity of *any* fuse ever made. The applications are in television, "life-saver" circuits, and the protection of delicate thermo-couples, bolometers, and galvanometers. Will break 20,000 volts.

Do you have use for such a fuse in your equipment?

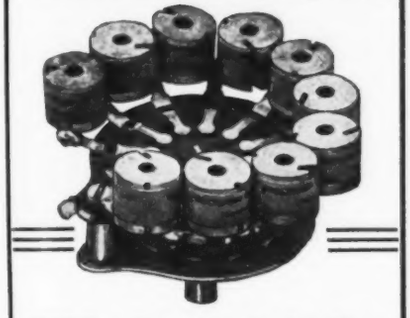
If so—when asking for a sample of this new world's smallest 1/1000 amp. VIDEO LITTELFUSE, give full details regarding current, voltage, possible surges, etc. Ask about it TODAY.

ACTUAL SIZE

VIDEO LITTELFUSE 1/1000 AMP. RATING

LITTELFUSE INCORPORATED
4248 LINCOLN AVE. CHICAGO, ILL.

MICROHM
WIRE WOUND RESISTORS



TYPE R Non-Inductive *facilitate* DECADE *and* OTHER ASSEMBLIES

Midgets in size but high in quality and accuracy. Diam. ½" x 7/16" long. Accuracy 1%. Available in a resistance range from 1 to 500,000 Ohms. Standard mounting with center hole to clear 6/32" screw. Designed for mounting by their terminals, making them adaptable for meter multipliers, decade and bridge assemblies. Small size recommends them for other uses. Accuracy of 1/10 of 1% available at slight extra cost.

Write for catalog and prices of Microhm PRECISION AND WIRE WOUND RESISTORS.

PRECISION RESISTOR CO.
332 Badger Avenue
NEWARK NEW JERSEY

Voltmeter. Sensitive electronic battery operated voltmeter, Model 300B, described in Bulletin 3. Ballantine Laboratories, Inc., Boonton, N. J.

"Chandelier" Speaker Baffle. Can be suspended from a single ceiling point. Described in Catalog F-39 along with other sound equipment of Atlas Sound Corp., 1447 39th St., Brooklyn, N. Y.

T-Line Transformers. Revised 14-page catalog containing audio and power applications in amateur transmitters, PA systems, and television. Kenyon Transformer Co., Inc. 840 Barry St., New York City.

Oscillograph. Type 175 Cathode-ray oscillograph described in current issue of "Oscillographer." Allen B. DuMont Labs., 2 Main Ave., Passaic, N. J.

Genemotors and Converters. Also new heavy duty power units for police short-wave radio. Circulars available. Carter Motor Co., 1608 Milwaukee Ave., Chicago, Ill.

Metal-clad Switchgear. Descriptive Catalog 8-a available. Roller-Smith Co., Bethlehem, Pa.

Phosphor Bronze. 48-page edition contains fundamental information on recent refinements and developments. Riverside Metal Co., Riverside, N. J.

Transformer Components. For industrial uses. Described in Bulletin PS-403. United Transformer Corp., 72 Spring St., New York City.

Police Radio. Catalog D-411 presents a complete line of Motorola police radio receivers including the new types, six-tube Model P69–12, and eight-tube Model P69–13 "Police Cruisers." Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.

Tube Test Equipment. Described in Catalog No. 10 which gives the various improvements made on equipment of Hickok Electrical Instrument Co., Cleveland, Ohio.

New Products

Measuring Equipment

DURING THE MONTH new types of electronic measuring equipment have been made available. A vibration proof indicating potentiometer known as Celectray, Model V, (C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.) employs photoelectric detection of the position of a light beam reflected from the mirror of a moving galvanometer; combines high-sensitivity with practically instantaneous response.

A VACUUM TUBE potentiometer with quinhydrone, antimony or glass electrodes, is available from Thwing-Albert Instrument Co., 3339 Lancaster Ave., Philadelphia, Pa.

For Ultra Sensitive Controls
TRIPLETT
INSTRUMENT RELAYS

Model 354

The Triplett Model 354 alarm relay shown here makes contact at 1 and 3 M.A. Other ranges and contact arrangements to order. Three case styles —projection, as shown, flush panel and portable.

DEPENDABILITY and flexibility in electrified controls. . . . A comprehensive line of highly sensitive relays used in connection with light sensitive cells for signal alarms, automatic inspection, counting apparatus, automatic lighting and many other applications requiring regulation with very narrow limits.

Fixed contacts are set in adjustable screws, allowing a wide adjustment of upper and lower limits of contact. Hardy metal, platinum, silver and platinum-iridium contacts. Single circuit-single contact and double circuit-double contact types (separate circuit or common connection). Among special developments is a locked contact type relay with manual release. Triplett engineers are interested in receiving your inquiries.

See the new Triplett 1939-40 line at the June National Radio Parts Trade Show — Booths 403–405.

Catalog Now Ready
Free on Request

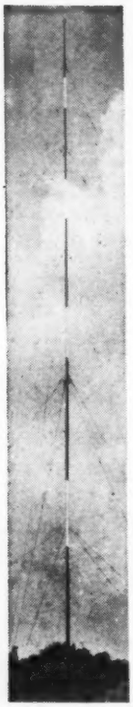
TRIPLETT *Precision*
ELECTRICAL INSTRUMENTS

The Triplett Electrical Instrument Co.
235 Harmon Ave., Bluffton, Ohio

Please send me complete information regarding relay applications.

Name .....
Address .....
City ..... State .....

WBTH
Going
KTSW
CKJB up!
CJKL
–all over
the country . . .
LINGO
Vertical Tubular Steel
RADIATORS



● Engineers are quick to recognize a product that proves itself by performance. Lingo "Tube" Radiators have turned fiction into fact by out-performing the most exceptional verbal or written claims made for them. No wonder so many are now in use—no wonder their users are such good boosters. Write to our customers—then write to us. Just send your location, frequency and power. All recommendations and costs will be promptly quoted without obligation.

Just off the press —

"Set Your Course by this New Star."

Write for new illustrated folder. Contains complete details and answers to your questions about Lingo Radiators. We'd like to send you a free copy right away.

LINGO Portable Dural Radiators

Write today for circular

Of extreme light-weight for emergency use. Can be erected by two men in 15 minutes. Compact, easily stored and transported. Standard lights, 40 to 100 feet.

John E. Lingo & Son, Inc.
Dept. E-5 Camden, N. J.

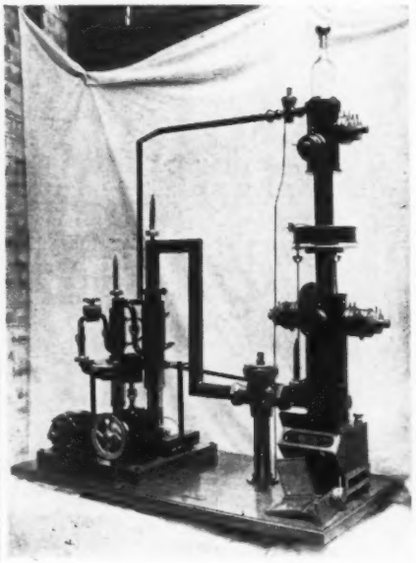
LINGO
VERTICAL
TUBULAR STEEL
RADIATORS

Bantam Junior Sockets

NEW MOLDED SOCKETS for the bantam junior tubes such as HY113, HY115, etc., for use in hearing aids, police pocket radios, remote controls, sensitive measuring devices and other compact apparatus are available from American Phenolic, 1250 Van Buren St., Chicago.

Diffraction Camera

AN INSTRUMENT WHICH opens up new possibilities the study of metal surface problems and known as the Finch electron diffraction camera is available from W. Edwards & Co., Vaughn Road, London, S. E. 5, England. Standard



camera complete with discharge tube, exhaust tubes, diaphragms, etc., lists at £115. A 3¼ x 3¼ plate camera for direct comparisons with a known material, lists at £17 16s, and a three stage mercury diffusion pump at £40 4s.

New Tubes

HYGRADE SYLVANIA announces three type 1802 Cathode-ray picture tubes with green, yellow, or white screens. Recent additions to Hygrade's receiving tube line are: 1N6G, 1Q5G, 7A4, 7C7, and 7E6.

FIVE INCH AND nine inch intensifier type cathode-ray tubes have been announced by Allen B. DuMont Labs., Passaic, N. J. The intensifier electrode provides a means for lowering the cost of television receivers and oscillographs of given image size and brilliance. This electrode consists of one or two gold rings deposited on the inside wall adjacent to the screen for accelerating the electrons after deflection.

RECENT RCA MFG. Co., (Harrison, N. J.) tubes are the 6J7-GT, 6K6-GT, 12J7-GT and 35Z5-GT.

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(Rates on Application)

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Tests of photo cells, glow lamps, crater lamps.
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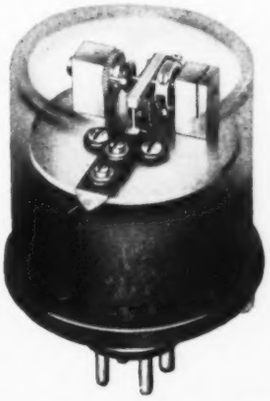
The Solution of Your Problem

in the field of Electronic devices may be found through enlisting the services of the Consultants whose cards appear on this page.

This is a highly specialized field and specialists are therefore better able to undertake the rapid developments necessary to keep in step with modern manufacturing progress.

SIGMA



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Do you have on file our Jagabi Rheostat Bulletin 1515-E. Write.

JAMES G. BIDDLE CO.
ELECTRICAL INSTRUMENTS
1211-13 Arch Street Philadelphia, Pa.

Power Level Recorder

An automatic high speed unit of Sound Apparatus Co., 150 West 46th St., New York City, is for use in making a continuous record of the results of acoustical and electrical measurements especially where great and rapid changes occur. Change of writing speed is provided in the instrument to make possible both high speed and high differential sensitivity. The paper speeds provided for high writing speeds are 50 and 5 mm/sec while slow speed writing speeds are 10 and 1 mm/sec. The input signal to be recorded is amplified and rectified and writing is accomplished by a stylus driven by a magnetic fork.

High-Gain Preselector

The unit uses an 1852 tube, and is complete with filament transformer in either kit form or wired and tested and is available from Browning Labs., 750 Main St., Winchester, Mass. The frequency range is from 64 to 1.6 Mc. The main dial is accurately calibrated in Mc. Vernier adjustment facilitaties sharp tuning on h-f bands.

Potentiometer Controller

Series 3200 units, of Wheelco Instruments Co., 1929 Halsted St., Chicago, are adapted to actuate any customary type of fuel valve or electric contactor. It features: instantaneous control action; is devoid of contacts, depressor bar mechanisms, cams, and other moving mechanical parts; can be used outside without danger of freezing; and no lubrication is necessary. Also announced is a dial-indicating thermometer dealing in temperatures from 0° F. to 1000° F. for industrial requirements.

Hi-Volt Indicator

A pocket type instrument (Ideal Commutator Dresser Co., Sycamore, Ill.) which when held in a changing static field lights up a glow tube indicating the presence of high voltage. Indication on 2,000 volts and up are given.

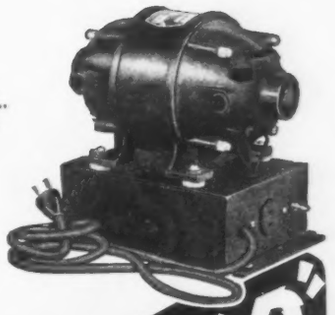
Copper Oxide Rectifier

General Electric Co. Schenectady, N. Y. announces a unit for oil circuit breaker operation. Rated at 50 amps, 120 volts d.c., 220 volts a.c. for two cycle operation not exceeding four per minute, this unit supersedes the former 3 amp unit, or multiple combinations of such units.

Relays

New relays for use in vacuum tube plate circuits are announced by Allied Control Co., Inc., 227 Fulton St., New York City. The coil is a 2500 ohm unit. Contacts will handle 5 amps, and pull-in on 8 ma and drop out on 5.5 ma.

"Pincor" Type "DA" Converter



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Radio engineers have learned from experience that Pioneer Gen-E-Motor Corporation's dynamotors, gen-e-motors and converters provide the last word in dependable power supply units for air craft, police, marine and auto radios and public address systems. They are available in a wide range of capacities for every requirement. Designed and constructed to give maximum long life and service. Light weight and compact. For complete information fill out and mail coupon below.

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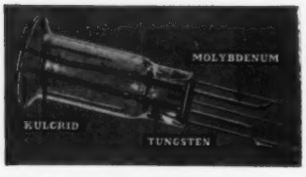
Leading tube manufacturers are well acquainted with the life-long dependability and production accuracy of Callite Tungsten—Molybdenum and Kulgrid lead-in wires. Don't accept inferior substitutes. Depend on Callite quality products for maximum production efficiency.



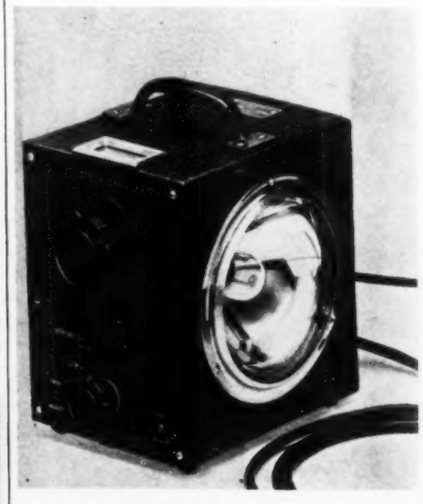
Call on Callite engineers for detailed information on fluorescent materials, lead-in wires and contact points.

CALLITE PRODUCTS DIVISION

EISLER ELECTRIC CORP. • 544 39th ST. • UNION CITY, N. J.

Stroboscopes

PORTABLE UNITS AVAILABLE from General Radio Co., Cambridge, Mass., suitable for both speed measurement and slow-motion studies of rotating and reciprocating mechanisms, such as motors, gears, etc. Type 631-B Strobotac supersedes Type 631-A. It consumes 25 watts. The light is directed on the machine under measurement (no mechanical or electrical contact is necessary), and the flashing rate can be adjusted until the motion appears stopped. Speeds between 600 and 14,400 rpm are read directly from a conveniently located scale and measurements can be made with an accuracy of ±1%. The instrument weighs 10 lbs. and measures 7½ x 8¾ x 10 ins. Type 648-A Strobolux furnishes about 100 times as much light as Type 631-B and can be used in conjunction with it when larger areas are to be illuminated or where background lighting is strong. It consumes 150 watts, weighs 25 lb., measures 13 x 11 x 13 ins., and can also be used as a light source for single-flash photography. Both units operate from an a-c line.



Controls

LOW POWER, WIRE WOUND, controls and rheostats are being introduced to the jobbing and the manufacturing trade by International Resistance Co., Philadelphia. These two-watt IRC controls cover all ranges up to 10,000 ohms and are equipped with a spiral connector providing postive continuous contact between rotor arm and end terminal.

Vacuum Guage

MODEL 20, "TRU-VAC" guage is an a-c operated Pirani or hot wire type. It has a self-contained amplifier and relay with a-c carrying capacity of 10 amps at 110 volts. Relay is fully automatic and will start or stop vacuum pumping operation at any pre-determined pressure. Bulletin TV-15 is available from Continental Electric Co., Geneva, Ill.

New RCA Equipment

DURING THE MONTH RCA announced a three-way microphone which is really a bi-directional velocity microphone and a non-directional pressure instrument. It is small in size, with a sensitivity of –62 db for a 10 bar signal. Another RCA product is a multi-range wave trap giving an attenuation at the tuning frequency of 40–1 from 450 kc to 2100 kc. New aircraft equipment comprises a frequency limit monitor; a new model aircraft microphone transmitting only the voice frequencies; new aircraft head phones; receivers for use by pilots in their homes for getting weather information; and a new light weight aircraft transmitter.

Photo-Head

A DEVICE CONTAINING a photoelectric cell designed to act instantly upon flame failure in furnaces, boilers, ovens, etc. In conjunction with Flame-o-trol, it shuts down the fuel supply with lightning speed, preventing entry of unburned fuel into combustion unit and eliminating this source of explosion hazard. Wheelco Instruments Co., 1929 S. Halsted St., Chicago.

Telephone

MODEL HT-3, OF Hallicrafters, Inc., 2611 S. Indiana Ave., Chicago, is a combination receiver-transmitter for service on small boats for direct communication with land telephones, Coast Guard, etc. It requires only connection to the ship's battery and an antenna.

Speakers

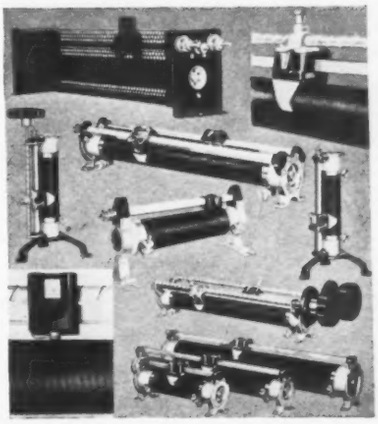
A NEW LINE OF 18 INCH auditorium speakers with permanent magnets is available from Jensen Radio Mfg. Co.,

Chicago. It is offered in four types to meet different requirements of response.

SLIDING CONTACT

RHEOSTATS

Every turn of the Wire a step of Control . . .



For Product Testing, Instrument Calibration, Laboratory Research and Development, for every operation that requires a fine continuous control of current and potential, you will find the Ward Leonard Sliding Contact Rheostat an ideal instrument. The sturdy construction makes them suitable for shop as well as for laboratory use. Various sizes and ranges are available for currents up to 25 amperes and voltages within their ratings, in vertical, horizontal and back-of-panel mountings, with or without micrometer drive. Send for Bulletin 8001.

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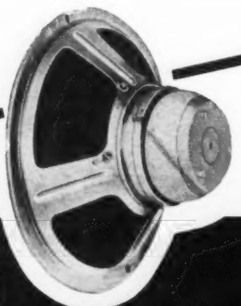
WHY CINAUDAGRAPH?

In recent years, an increasing number of manufacturers of receivers, amplifiers, recording apparatus and other communication equipment have turned to Cinaudagraph for speakers.

WHY CINAUDAGRAPH?

Because an extensive engineering staff and volume-production facilities have enabled Cinaudagraph to offer *high quality speakers at competitive prices.* Because Cinaudagraph has been able to meet not only the budget demands of these manufacturers, but also the "service factor"—so vital in maintaining production costs at estimated levels.

Cinaudagraph will be glad to quote on your requirements, and invites your inquiry. Also, catalog sent on request.



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THERE'S a vital "vitamin" in C-D motor capacitors that makes these units completely dependable. It's called Dykanol "A", (Chlorinated Diphenyl).

The high dielectric strength and constant, stable chemical characteristics under all operating conditions, and non-inflammable nature of Dykanol "A" used in the type CM capacitor series makes them a safe and sound investment for A.C. capacitor type motors. Available in a complete capacity range at 175–220, 330, 440 and 660 V.A.C. 60 cycle.

Send for copy of catalog No. 160. It gives full information about C-D's complete line of capacitors for industry's every need.

Product of the World's Largest Exclusive Manufacturer of Capacitors

CORNELL-DUBILIER ELECTRIC CORPORATION

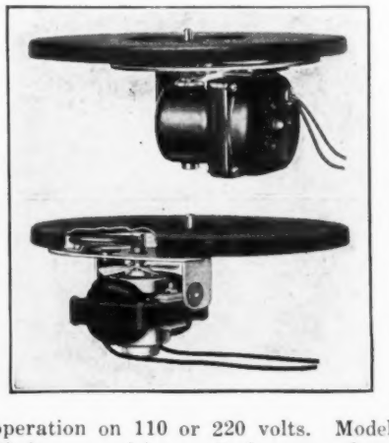
1022 Hamilton Boulevard, South Plainfield, New Jersey

Hearing Aid

THIS VEST POCKET UNIT available from the C. L. Hofmann Corp., Pittsburgh, utilizes 3 vacuum tubes, a crystal receiver and microphone, and contains everything except batteries and the air receiver. The tube filaments operate from 1.5 volt batteries.

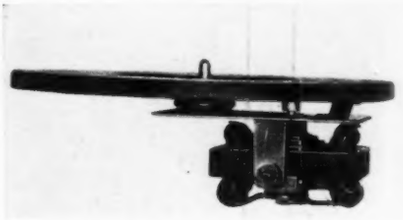
Recording and Reproducing Apparatus

DURING THE MONTH several pieces of apparatus of interest to recording engineers have been announced. Among them are two phonograph turntable motors, one by the Alliance Mfg. Co., Alliance, O., whose "Even-Speed" Models 60 and 70 are available for



operation on 110 or 220 volts. Model 60 is a precision unit for use where superior speed regulation under wide variations, of voltage, load and temperature may be desired. Model 70 is a less expensive unit, simple in operation, with good regulation.

Webster-Chicago Company have announced a rim drive turntable motor in which the motor, operating at relatively low speed, drives the turntable through a pulley so that the angle of velocity of the rim drive is more than it would be



were the motor pulley in contact with the turntable rim. This eliminates turntable vibration due to resonance according to the manufacturer.

Two playback units are designed for broadcast stations, advertising agencies, etc. Both units are portable. The Terminal Radio Corp. (68 W. 45th St., NYC), unit weighs 32 lbs., accommodates discs up to 17¼ ins., uses a crystal pickup, and a 10 in. Cinaudagraph PM speaker.

Charles Michelson Co., 454 Fifth Ave., New York City, unit weighs 20 lbs., accommodates records up to 16

ins., uses a 6 in. dynamic speaker and a 3 tube amplifier.

Duplex Recording Devices Co., 514 W. 36th St., New York City, have perfected a two speed gear driven 16 inch professional recorder free from wows and vibration. A flexible shaft attached to an independent train of gears driven by the recorder motor can be used to drive any 16 mm hand-crank camera either at 16 or 24 frames per sec synchronized with the recorder.

Auto Antennas

COWL ANTENNAS FOR automobile radio use have been announced by Insuline Corp. of Amer., 25 Park Place, and Philson Mfg. Co., Inc., 156 Chambers St., New York City. Both antennas are adapted to be quickly and easily installed in old or new cars.

Police Radio

HARVEY RADIO LABS, Inc., Cambridge, Mass., announce a new line of two-way police radio equipment. This comprises mobile transmitters and receivers as well as central station equipment, covering frequency range from 30-40 Mc.

Smoke Controls

TWO DEVICES GIVING warning of faulty combustion have been announced.

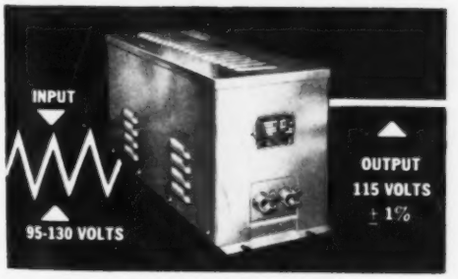
THE PHOTO SWITCH INC., (Cambridge, Mass.) unit operates a bell or other signal in the boiler room when smoke passing through a furnace flue exceeds a predetermined density.

A RECORDER MANUFACTURED by the Practical Instrument Co., 2717 N. Ashland, Chicago., operates a warning bell and makes a record which shows the number of times, the length of time, and the hour of day that the smoke in the Pure Oil Bldg., Chicago, chimney was sufficient to operate a photoelectric cell.

Megabridge

AN ADAPTATION OF THE Wheatstone bridge, utilizing an electron ray null indicator in place of a galvonometer. The bridge operates from an a-c power line and has a self contained d-c supply for the bridge circuit and the indicator tube. It utilizes one 6N5 tube, one 1V and two voltage regulator tubes. Eight models are available depending upon the resistance range to be measured. Industrial Instruments Inc., 162 W. 23rd St., Bayonne, N. J.

Stabilized AC Voltage for Amplifiers and Rectifiers [*AC Input 2 VA to 25 KVA*]



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With input varying from 95 to 130 volts AC, 60 cycles output is maintained at 115 volts ± 1%. Stabilizes at any load within rating. Other voltages and frequencies to order. A magnetic unit with no moving parts or adjustments. Action is instantaneous. Sizes from 2 VA to 25 KVA. Write for literature.

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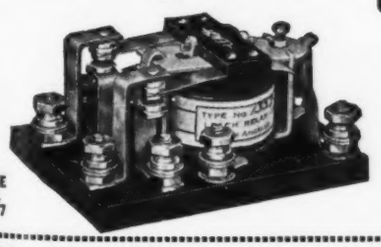
LEACH LR RELAYS *you can depend upon their* **OPERATING RELIABILITY**



Leach small size circuit control relay, type No. 1357 is a compact, rugged and reliable control relay ideal for your control circuit. These relays have solid cores, positive contact and low current consumption—built so that you can depend upon them!

LEACH RELAY COMPANY

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LEACH RELAY COMPANY, 5915 Avalon Boulevard, Los Angeles, Calif.

Please send your catalog. I am interested in.....type relay.

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Company .....

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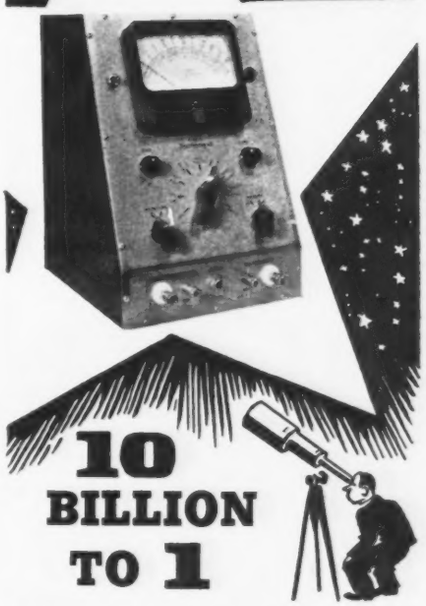
Outstanding



10 BILLION TO 1

LIKE THE STARS IN THE HEAVENS ten billion to one is beyond comprehension, yet that is the ratio of the resistance range of the Rider VoltOhmyst. Electronic engineers have been quick to visualize the lasting usefulness of this new Electronic D-C Voltmeter-Ohmmeter with ranges wide enough for the engineering requirements of today and tomorrow. It is designed for use on television, radio facsimile and aircraft receivers and transmitters, sound power, and other engineering work.

The Rider VoltOhmyst measures 0.05 to 5000 volts D-C in nine ranges—0.1 ohm to 1.000.000.000 ohms in seven decade ranges with a greater convenience than any other existing instrument. As an example, you can measure any D-C control or operating voltage wherever it may be without being concerned with the circuit complications—with the signal present in the circuit. For, the Rider VoltOhmyst has one scale—one zero adjustment. You just put the proper probe on the point to be measured and the scale shows the voltage or resistance without any adjustments as you change ranges. 3% accuracy on the Ohmmeter, 2% on the Voltmeter. Input resistance of the Voltmeter is 16.000.000 ohms up to 500 volts and 160.000.000 ohms from 500 to 5000 volts.

Operates over 105-130 volts, 25-60 cycles. NET PRICE $57.50

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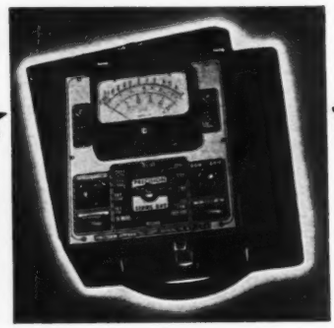
As Good as it looks!

Examine any one of our products INTERNALLY. . . . Ask your jobber to open one for you. . . . Note the craftsmanship and the infinite care in construction and wiring. . . . Not a single tested and advanced engineering refinement is omitted even though our prices remain surprisingly LOW. . . .



"PRECISION" Series 842–P
With a 2500 volt AC-DC Range

★ Large size 4½ inch square meter.
★ FIVE AC and DC VOLTAGE RANGES at 1000 ohms per volt: 0 to 10/50/250/1000/2500 volts.
★ SIX DC CURRENT RANGES: 0 to 1/10/50/250 MA: 0-1: 0-10 AMPS.
★ FOUR RESISTANCE RANGES: 0-400 ohms (20 ohms center). 0-100,000 ohms. 0-1 megohm. 0-10 megohms. NOTE: Provisions for mounting ohmmeter power supply (4½ and 45 v batteries) on inside of case. No external connections necessary.
★ FIVE DECIBEL RANGES from —10 to +63 DB; ODB; +14 DB; +28 DB; +40 DB; +48 DB.

842-P. Size 9x10x6. Housed in walnut finished wood portable case with removable cover. Less batteries and test leads. Net Price **$23.95**

Available at Leading Distributors
Following is a partial list

Albany, N. Y......Ft. Orange Radio Dist. Corp.
All branches.....Wholesale Radio Service Co.
Birmingham, Ala.....E. E. Forbes & Son
Charlotte, N. C......Shaw Distributing Co.
Chicago, Ill......Lukko Sales Corp.
Cleveland, Ohio.....Winterradio Inc.
Corpus Christie, Texas....Frank Mayer Co., Inc.
Denver, Colo.....Inter-State Radio & Supply Co.
Hagerstown, Md......Zimmerman Wholesalers
Hazelton, Pa......Robert A. Sylvester
Indianapolis, Ind......Radio Distributing Co.
Lincoln, Nebr......Hicks Radio Company
New York, N. Y......Sun Radio Company
New York, N. Y......Terminal Radio Corp.
Norfolk, Va......Radio Parts Distributing Co.
Orlando, Fla......Radio Accessories Co.
Seattle, Wash......Northern Radio Company
Spokane, Wash......Spokane Radio Company
Washington, D. C......Rucker Radio Wholesalers
Wichita, Kansas....Stewart Warner Products Co.

STANDARD OF ACCURACY
PRECISION
TEST EQUIPMENT
SEE THEM AT YOUR JOBBER

PRECISION APPARATUS CORP.
647 Kent Avenue, Brooklyn, N. Y.
Export Division—458 Broadway, New York City, U. S. A.
Cable Address: Morhanex

Transformers

AIR-COOLED CONTROL and warp-stop loom transformers to provide voltage changes for small motors, electronic tubes, relays, control circuits, etc. They adhere to Underwriters' Labs and are manufactured by Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

DESIGNED ESPECIALLY FOR television sound and picture channels, F. W. Sickles Co., Springfield, Mass., announce a perm-trimmed transformer which permits maximum gain per unit with desired band width for high definition television. The trap circuits required to eliminate from the picture channel the interference caused by its sound carrier, and also adjacent channel sound carrier, are included as part of these transformers. Terminals extend from both ends of the shield. A typical response curve was illustrated on page 42 March 1939 *Electronics*.

Electronic Switch

AS A MEANS TO end sticking and arcing contact troubles on such equipment as thermostat regulators, small limit switches, or any type of equipment requiring low contact pressure, United Cinephone Corp., Long Island City, has developed an electronic switch. It utilizes a 6J5 tube, power output is 3 watts at 110 volts, and it will operate with contact resistances up to 500,000 ohms.

Sound Level Meter

JOHN MECK INSTRUMENTS, 164 N May St., Chicago, has developed a portable

sound level meter adapted for laboratory or field work. The range of measurements is from + 50 to + 125 db.

Vibrators

SYNCHRONOUS AND non-synchronous vibrators for use in self-contained portable receivers using 1½ volt and 3 volt batteries are available from American Television & Radio Co., St. Paul, Minn. The efficiencies of power supplies using these vibrators are 50 to 60%.

NEW BOBBIN
STURDIER • BETTER INSULATED • LOWER COST

SQUARE...RECTANGULAR...
FOR SMALL TRANSFORMERS . . REACTORS . . A. C. RELAYS . . SOLENOIDS . . VIBRATORS

ROUND...
FOR SOLENOIDS . . RELAYS . . SIGNALS . . BELLS . . BUZZERS

Write for Prices and Samples
PRECISION PAPER TUBE COMPANY
Manufactures Square, Rectangular, Round Tubes
2033 W. CHARLESTON STREET CHICAGO, ILLINOIS

HAVE YOU A "PLUG PROBLEM"?

CANNON PLUGS are manufactured up to a standard, not down to a price . . . they are fashioned for those who demand dependability, who know that failure spells loss, perhaps disaster—as in Sound studios, Aircraft service and many parallel applications. Dependability, precision, exacting standards, rugged quality and variety of fittings—these are factors that have made CANNON CABLE CONNECTORS leaders in their field. Over 1,000 stock parts are always available. Descriptive Bulletins afford valuable information and may assist you in solving your "plug" problems. When requesting Bulletin, please specify your requirements.

Cannon Plugs are pre-eminent in the fields of Sound, Aeronautics, Geophysical Research, Instrument Control on Ships and Laboratory Panels.

CANNON ELECTRIC DEVELOPMENT CO.
★ 420 West Avenue 33, Los Angeles, California
★ *EASTERN SALES OFFICE*, 220 Fifth Ave., New York, N.Y.

CANNON PLUGS

Electron Tube Applications

Motor Control. Circuit involving a tube with a floating grid. G. Failla, New York, N. Y. 39 claims. No. 2,145,866.

Regulating System. A fluid regulating system comprising valve, motor, etc., controlled by tube. O. E. Stoessel, Chicago, Ill. No. 2,144,668.

Welding Control. Speed of operation of feeding means is regulated between certain limits to regulate the rate at which the electrode is fed to the work. H. E. Kennedy, etc., Union Carbide & Carbon Corp. No. 2,145,010.

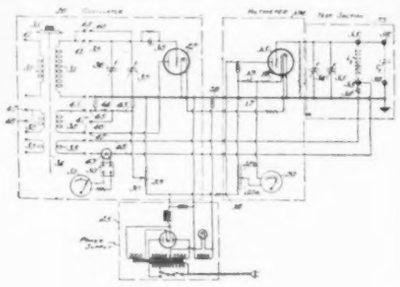
Telemetering System. G. T. Huxford, Builders Iron Foundry. No. 2,145,026.

Measuring Apparatus. Means whereby the angular spread of light rays illuminating a cell over two different solid angles may be indicated by a photoelectric instrument. A. H. Wolferz, Weston Electrical Instrument Corp. No. 2,145,147.

Musical Instrument. Device for incepting and modulating tone-frequency currents. C. E. Williams, Hammond Instrument Co. No. 2,142,580.

Traffic System. Method for policing several vehicles in traffic by means of a radio receiver tuned to a given radio frequency representative of a prohibited range of speed. D. E. Marshall, Palos Verdes Estates, Calif. No. 2,140,918.

Q Meter. Method of determining the relative Q values of several in-



ductors. H. A. Snow, Boonton Radio Corp. No. 2,137,787.

Measuring and Regulating Devices. Combination of dynamo-electric machine, grid-glow tube, light sensitive device, etc., whereby a movable graph-member is actuated in accordance with the condition of the dynamo-electric machine. G. V. Woodling. No. 2,139,295.

Cleaning Apparatus. Apparatus for treating material infested with im-

Listen to the New Shure DYNAMIC MICROPHONES

You'll find a new kind of performance in these sensational new Shure Dynamic Microphones—*IMPROVED* performance based on the very latest developments in electroacoustic engineering—at low costs.

SERIES 55 "UNIDYNE" UNI-DIRECTIONAL

Gives true cardioid-type uni-directional pickup—Gets the sound you want, free from feedback and audience noise. Smooth high-quality wide-range response. Low and high impedance models, with 25 ft. cable, at $42.50 and $45.00 list.

SERIES 50 "ROCKET" GENERAL-PURPOSE

New moving-conductor type, with smooth wide-range response that sets a new quality standard for economically priced Dynamic microphones. Exceptionally rugged. Three models in low and high impedances, with 25 ft. cable, at $27.50 list. High impedance model, with 7 ft. cable at $26.00 list.

Sound Systems Sound Better With Shure Microphones.

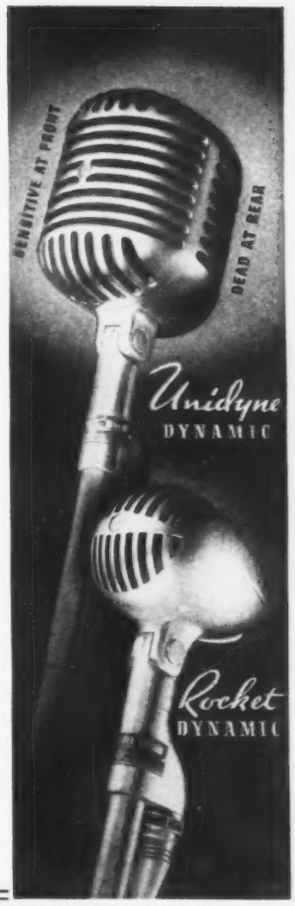
Write Today for Catalog 150M.

SHURE

Shure Patents Pending

SHURE BROTHERS, 225 W. Huron St., Chicago, U.S.A.

Designers and Manufacturers of Microphones and Acoustic Devices



Aesop said . . .

"little friends may prove GREAT FRIENDS"

R-100 Relay

Type R-100, a small relay especially designed for radio use, short wave therapy and diathermy machines, etc., in H.F. and U.H.F. circuits. Has dozens of applications.

No larger than the mouse that freed the lion—Relays by Guardian possess the power to solve many perplexing product design and assembly problems, where, like the lion's helpless hulk, the mechanical method is too awkward, too bulky, too slow and expensive to compare with efficient control assemblies using Relays by Guardian.

Use *Controls by Guardian:* small, compact stepping switches, contact switches, solenoids, time-delay, muting and holding relays—singly—or in innumerable combinations with discs, metal housings, brackets and special parts . . . every part designed, fabricated and tested in one plant . . . Guardian's!

ANY QUANTITY AS YOU WANT THEM—WHEN YOU WANT THEM

Write for Catalog "E" Today! Now!

GUARDIAN ELECTRIC

1625 W. WALNUT STREET CHICAGO, ILLINOIS

NBC, HOLLYWOOD

(Continued from page 14)

may be a large number of studios and other program inputs from which the program material may be supplied, but the number of different simultaneous programs is limited and always considerably less than the number of outgoing channels or than the number of available program inputs.

Normal operating procedure used with the program switching system is as follows:

Schedule sheets prepared in advance, show the program activities for an entire day and indicate program sources, whether from a studio, a field point or from an incoming network. Information concerning outgoing channels or services taking the programs is furnished by teletyped traffic orders and, at the start of operations, the required channels for each separate program are pre-set on convenient separate switchbanks by operating the numbered key switches.

Connection of any switchbank to a particular studio is accomplished by operating the associated key switch on the switchbank selector panel, one such panel being associated with each separate studio or other program input circuit. When the foregoing operations are performed, the "Carrier" lights at the announcers' control desk in the studio and at the engineers' console in the booth, are illuminated, the signal for the program to proceed. The program or announce microphones, or possibly a nemo program, is thereupon connected to the studio mixer by operating the proper set-up buttons which are provided, both at the announcers' control desk in the studio and at the engineers' console in the control booth. The actual connection of channels to the output of the studio is then effected by operating either the "network" or "local" set-up buttons at the same locations. Thus the program is transmitted to the networks and ultimately

TYPE 176

Low Cost
Reliable
Small

FIXED CAPACITY
COMPRESSED GAS CONDENSER

Capacity: 50-2000 mmf.
Price: $162-$325.
Voltage: 40 kv. peak rating.
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SOUTH SAN FRANCISCO LTD. CALIFORNIA U.S.A.

RCA

Frequency Measuring Service

WORLD WIDE WIRELESS

Many stations find this exact measuring service of great value for routine observation of transmitter performance and for accurately calibrating their own monitors.

MEASUREMENTS WHEN YOU NEED THEM MOST
at any hour every day in the year

R.C.A. COMMUNICATIONS, Inc.
Commercial Dept.
A RADIO CORPORATION OF AMERICA SERVICE
66 BROAD STREET NEW YORK, N. Y.

FOR MICROSCOPIC PRECISION

USE THE MICRO TYPE Z SWITCH

A supersensitive switch specially suited for service in:

Instruments
Temperature Controllers
Gauging Machines
Weighing Machines
Meters

Write for specifications and recommendations covering specific applications.

1—Heater loads 1200 watts up to 600 volts A.C. Also inductive loads, solenoids, and relays. ½ h.p. up to 460 volts A.C.
2—Operates on .0002" to .0003" movement and 1¼ to 2 ounces pressure differential.
3—Can be used in any position—vibration resistant.
4—60 or more snaps per minute.
5—Underwriters' Laboratories listing and Ontario H. E. P. C. approval.

Size 1 15/16" x 27/32" x 11/16".

Type Z

MICRO SWITCH CORPORATION
23 EAST SPRING STREET FREEPORT, ILL., U.S.A.

The CARRIER Dynamic Model 702-D with the new "Acoustic Equalizer" represents the greatest advancement in microphone design. Never before has a microphone been presented with all of the features of the CARRIER Model 702-D. Whether for close talking or distant pickup the 702-D retains its distinct, natural quality free from sharp resonant peaks. Successfully used for wide-range broadcasting, recording and sound reinforcing.

Response ±2 db. 30 to 10,000 cycles. Output level — 60 db.

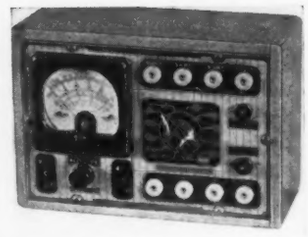
List price 30 ohms, $60.
200 or 500 ohms, $68.50.

Send for catalog 10-A describing the complete CARRIER line.

CARRIER MICROPHONE CO.
439 So. La Brea Ave.
INGLEWOOD, CALIF.
(suburb of Los Angeles)
9 So. Clinton Street CHICAGO, ILL.
15 East 26th Street NEW YORK CITY

If takes even TELEVISION *in its stride!*

NEW RCP *Supertester* MODEL 411



A SINGLE glance at the long list of imposing features is enough to convince engineer, technician or serviceman of SUPERTESTER'S amazing flexibility. In radio set and amplifier—in any industrial plant doing laboratory or production line testing, this SUPERTESTER is "must" *equipment.*

In service work on electrified games . . . in circuit checking and—yes, in Television, RCP's

Model 411 is the ideal instrument. Complete.... **$16.25**
Model 411B with provision for direct reading test of ballast tubes....$17.95
Model 411P same as 411 except in hinge cover case $17.95.

FEATURES

5 stage high AC-DC voltage range to 5000 volts. 3 stage high AC-DC current range to 25 amps. DC milliamps 0/10/100. AC milliamps 0/500. DC microamps 0-200.
3 stage ohmmeter range to 4,000,000 ohms. 5 stage db meter from—10 to 69 db. High voltage not applied to selector switch or to general test circuits. All bakelite, new design, jacks used only. Center of scale, on low ohmmeter range only 5 ohms with each of first ten divisions measuring 0.1 ohm. 3" square meter with movement of 200 microamps or 5,000 ohms per volt.

ANNOUNCING!
New Electronic Multitester

Engineers at RCP labs announce the new Electronic vacuum tube, volt - ohmmeter model 660. Tests up to 5,000 V.D.C. and 0.1 ohm to 1,000 megohms. Ultra high impedance and operating simplicity make this instrument ideal for production line as well as laboratory test applications. Model 660 Electronic Multi - tester supplied in hardwood tilted carrying case. Your inquiries are invited.

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You've got to try this test instrument to know its value, versatility, accuracy and ease of operation. Write for bulletin describing the SUPERTESTER and other models in the *dependable* quality RCP line of test equipment.

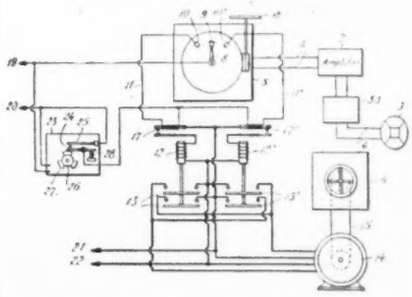
RADIO CITY *Products Co.* INC
88 PARK PLACE NEW YORK CITY

purities of the type which have high dielectric losses when subjected to a high frequency field. I. E. Mouromtseff and H. V. Noble, WE&M Co. No. 2,138,935.

Measuring Device. An electronic gage for measuring the thickness of a coating. L. A. Danse, Detroit, Mich. No. 2,136,675.

Detection Device. Apparatus for detecting the presence of foreign bodies on the bottom of a transparent vessel. N. P. Stoate, London, England. No. 2,137,187.

Mill Control. Control of a crushing or grinding mill in which the level of noise emitted by the mill in operation



is a function of the quantity of material therein. C. F. Roder, assigned to F. L. Smidth & Co., New York. No. 2,136,907.

Repair radios expertly

This book gives the essentials of theory and technique that clarify radio troubles and help you make quick, accurate repairs.

Just Out!

Principles and Practice of
RADIO SERVICING
By H. J. HICKS
Radio Instructor, Hadley Vocational School

300 pages, 6 x 9, 212 illustrations, $3.00

INCLUDES CHAPTERS ON:
—selecting and using test equipment
—servicing public address systems
—getting and keeping service business

Shows how to install, test, and repair radio receivers, giving not only instructions in all the servicing procedures, but also plain treatment of the theory of electricity and radio needed for most effective approach to servicing problems. Written in excellent self-study style for servicemen who want to improve their skill and readers who want to learn this practical field from the ground up.

10 DAYS' EXAMINATION ON APPROVAL—SEND THIS COUPON
McGRAW-HILL BOOK CO., INC., 330 W. 42nd St., N. Y. C.

Send Hicks—Principles and Practice of Radio Servicing for 10 days' examination on approval. In 10 days I will send $3.00, plus few cents postage, or return book postpaid. (We pay postage on orders accompanied by remittance.)

Name .....

Address ..... City and State .....

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(Books sent on approval in U. S. and Canada only.)

CHECK YOUR OIL, sir!

When you make this your service station there's no need to use the old "oil" on your customers. With real values to offer you can forget the high-pressure stuff. And it's real values you get when you order from Wholesale Radio Service Company. We stock only top-quality equipment — all nationally advertised goods. We carry a complete line of more than 50,000 radio items. You can't beat the prices. Shop here and watch your business step on the gas!

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100 SIXTH AVE., NEW YORK, N. Y.
CHICAGO, ILL. · ATLANTA, GA. · BOSTON, MASS.
BRONX, N. Y. · NEWARK, N. J. · JAMAICA, L. I.

it, by means of individual cabinet type loudspeakers equipped with high-impedance-input power amplifiers. Program selection is effected by means of dial selectors mounted in small control boxes which are installed at the respective office desks.

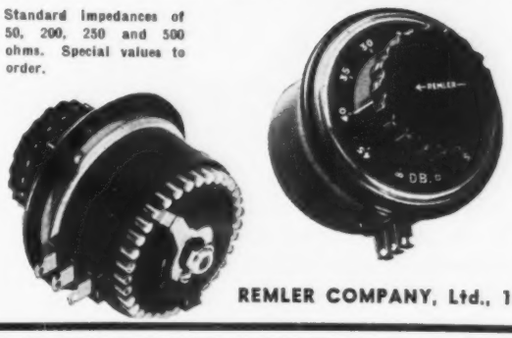
Four channels for "acetate" recording, complete with turntables and cutter amplifiers are installed at the Hollywood studios. These are used chiefly for reference purposes both from the standpoint of program analysis and build-up, and legal record.

Interconnecting Telephone

All studio control booths and staff offices are interconnected by a private automatic telephone system. An additional "trouble alarm" circuit connects together, for conference, the Master Control Desk, Main Equipment Room, Maintenance Shop, and any one of the studio control booths. This alarm is set off by the engineer in the control booth of any studio having equipment trouble, and brings together those of the staff who are available when the emergency arises.

• REMLER ATTENUATORS

Standard impedances of 50, 200, 250 and 500 ohms. Special values to order.



Silver contacts; ball-bearing rotor shaft; clock spring pigtail. Single sliding contact in input circuit results in contact noise being attenuated within the unit in direct proportion to loss introduced in the circuit providing constant noise-to-signal ratio. Impedance practically constant over entire range of pad. Long life; trouble-free service . . . famous Remler quality.

REMLER COMPANY, Ltd., 19th at Bryant, San Francisco

Police and Broadcast Engineers can now obtain improved frequency control of their high frequency transmitters with the type MO2 holder or MO3 Constant Temperature Oven complete with a Bliley High Frequency Quartz Crystal. These two units have been specially designed for rigorous service in mobile and portable transmitters. Catalog G-10 contains complete information on these and other Bliley Crystal Units. Write for your copy today.

BLILEY ELECTRIC CO.
UNION STATION BLDG., ERIE, PA.

SEARCHLIGHT SECTION

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10 cents a word, minimum charge $2.00.

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Proposals, 40 cents a line an insertion.

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Box Numbers in care of our New York, Chicago, or San Francisco offices count 10 words additional in undisplayed ads. Replies forwarded without extra charge.

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The advertising rate is $6.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.

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ELECTRICAL ENGINEER, age 26, desires permanent position anywhere. Experience three years production manager of factory for communication equipment; research work; mechanically skilled; designer for tools. Excellent references. PW-204, Electronics, 330 W. 42nd St., New York, N. Y.

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Is it complete?
Are you expanding it?
Making replacements?

Naturally, you are anxious to secure the most suitable man or men available. You want men with the special training that will make them an asset to your organization. You can contact such men through a Position Vacant advertisement in the Searchlight Section of ELECTRONICS

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FORMER CUSTOM RADIO ENGINEER, now employed in well known manufacturer's electronics division, available for employment by radio components, transmitter, or receiver manufacturer. Prefer location either in New York or New England. Highly inventive, versatile, with experience over wide range. Age 28, single. Salary subject to discussion. Photo and details upon request. PW-206, Electronics, 330 W. 42nd St., New York, N. Y.

PUBLIC ADDRESS ENGINEER—Experienced in layout, design, construction, installation and test of centralized control equipment for schools, hospitals, institutions, inter-communicating systems, radios, phonographs. Sales experience. Presently employed, but wants better opportunity. PW-207, Electronics, 520 N. Michigan Ave., Chicago, Ill.

LICENSED RADIO TELEPHONE OPERATOR, first class. Graduate Capitol Radio Engineering Institute. Six years radio service. Present position three years, service, receivers—electric organs—design, construction and installation public address equipment. Amateur station seven years. Familiar with broadcast procedure and equipment. Age 24. Desires position in broadcasting or manufacturing field. Construction maintenance or installation preferred. PW-205, Electronics, 330 W. 42nd St., New York, N. Y.

HIGH GRADE USED
ELECTRON TUBE MACHINERY
Huge Stock of Every Type and Variety
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Specialists in Equipment for the Manufacture of Neon Tubes, Radio Tubes, Incandescent Lamps, Photo Cells, X-ray Tubes, etc.
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DEPENDABLE
Used
ELECTRONIC TUBE EQUIPMENT
A complete line of used equipment for the manufacture of Radio Tubes, Neon Tubes, Incandescent Lamps, etc.
Write for Bulletin showing savings from 25 to 75%
EISLER ELECTRIC CORP.
534 39th Street, Union City, N. J.

New "SEARCHLIGHT" Advertisements
must be received by **May 10th** to appear in June issue.

Address copy to the Departmental Advertising Staff

Electronics
330 West 42d St., New York City

to the many radio transmitters on the chain.

With any given program in progress, succeeding combinations may be pre-set at leisure, and a single operation, the turning of the non-locking "Carrier Release" key by the announcer or engineer in the studio or control booth, automatically transfers all channel groups on the switchbanks to new studio inputs or, in the case of new channel combinations, to new switchbanks as well.

The Chimes Circuit

Since NBC normally operates two or more networks, a synchronizing feature, usable at the discretion of Master Control, is in use. This detail concerns the operation of the NBC chimes circuits. The chimes are primarily a cue signal to the networks that the program from the originating point will be interrupted for a certain period, during which time the various local stations can identify themselves by announcing their own call letters. Either during, or at the conclusion of the period, the network and studio switching operations take place. The synchronizing circuit "stores" the chimes operations impulses from the various studios until all have been received, at which time the chimes are transmitted. Any of the studios may be connected to or disconnected from the synchronizing system at the Master Control Desk. This feature is necessary to prevent holdup of all networks when any single program termination is unavoidably delayed.

Loudspeaker program monitoring is provided in the offices requiring

PERMANENT MAGNETS

ALL SHAPES — ALL SIZES
FOR ALL PURPOSES

Stamped, Formed, and Cast; Chrome, Tungsten, Cobalt and **ALNICO**** (cast or sintered) under G. E. license.

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Laminations for Radio Transformers — Tools
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FOR THE FIELD OF ELECTRONICS

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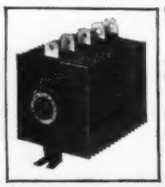

CHANGE AC TO DC WITHOUT MOVING PARTS,
GLASS BULBS, LIQUIDS, OR SPARKING CONTACTS.
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COMPACT—ECONOMICAL SPECIAL RECTIFIERS AND COMPLETE ASSEMBLIES

THE BENWOOD LINZE CO.
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ELECTRICAL RECTIFIERS
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★ **CAESIUM AZIDE**

★ *A Source of Purest Metal*
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Also other Caesium Salts and Azides of the alkaline and alkaline earth metals.
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Write Alden Your Problem
On every multi-wire, connector, socket problem with or without special cable. Special attention to giving you a completed cable with every consideration for it to meet every kind of requirement —mechanical, shielding, low capacitance, complicated either as to leads or covering. Also flat-woven cable with any number of leads with and without connectors, 48-hour service on leads cut to length with ends stripped, twisted and solder dipped.
ALDEN PRODUCTS COMPANY
717 Center Street Brockton, Mass.

FINE RIBBONS
of **Tungsten, Molybdenum and Special Alloys**
To your specifications
H. CROSS
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A NEW VACUUM GAUGE
Featuring simplicity and low cost suitable for continuous measurements between 76 Cm. and 0.1 micron will soon be available. Write for advance information.
VACUTRON, INC.
20 West 22nd St. New York, N. Y.

VACUUM TUBES AND ELECTRONIC DEVICES
Design, Development, Construction to specifications. Let us develop your idea. Coils, etc., sealed into cans or bulbs.
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MICROMETER FREQUENCY METER for checking transmitters, up to 56 megacycles
LAMPKIN LABORATORIES
BRADENTON, FLORIDA

FILMGRAPH
Newly patented—instantaneous SOUND-ON-FILM RECORDER and REPRODUCER. No processing required. Special models to make "TALKIES" in conjunction with cameras or SILENT as well as sound projectors. Also models for use with or without pictures, 84 minutes of recording on 100 feet of 16 mm. film costing only 85 cents. Moderate initial cost of FILMGRAPH—only expense for SOUND-ON-FILM. MILES REPRO. CO., 812C Broadway, N. Y.

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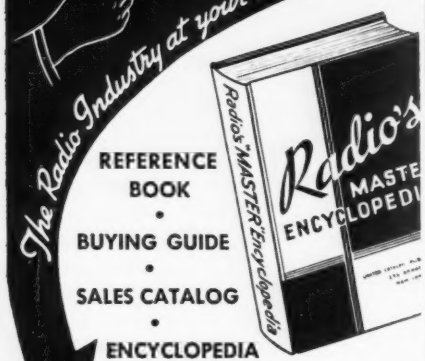
The Insulated dial light sockets for AC DC sets that are used in nearly all the Underwriters' approved sets are Alden. Sketch your exact mounting problem and samples and prices will be forwarded promptly. All our dial light sockets have the minimum number of parts so they can be supplied to you with leads at the lowest possible overall cost.
ALDEN PRODUCTS COMPANY
717 Center Street Brockton, Mass.

We manufacture a complete line of equipment
Spot Welders, electric, from ¼ to 500 KVA
Transformers, special and standard types
Incandescent lamp manufacturing equipment
Radio Tubes, ex-ray, cathode ray, photo cells
Electronic equipment, vacuum pumps, etc.
Tungsten slugs, rod and wire manufacturing equipment
General glass working machines and burners
College glass working units for students and laboratory
Ask for our Bulletin on new type vertical Bench Welders

EISLER ENGINEERING COMPANY
751 So. 13th St. (near Avon Ave.) Newark, New Jersey

Radio's MASTER ENCYCLOPEDIA

The Radio Industry at your Finger tips



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THE ONLY OFFICIAL EQUIPMENT MANUAL of the Radio Industry!

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Compiled in cooperation with and approved by Radio Manufacturers, this authentic source book of over 600 pages is crammed full of vital, essential information that is indispensable to everyone identified with Radio and allied lines.

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The New 1939 Edition of Radio's Master Encyclopedia is the most comprehensive ever issued. No other book like it. Important data that you need in your business—conveniently cross-indexed for split-second reference. Thousands of illustrations, specifications and prices on every conceivable type of Equipment, Accessories, Parts; ranging from Tubes to Transmitters, and including the latest in television tubes and parts.

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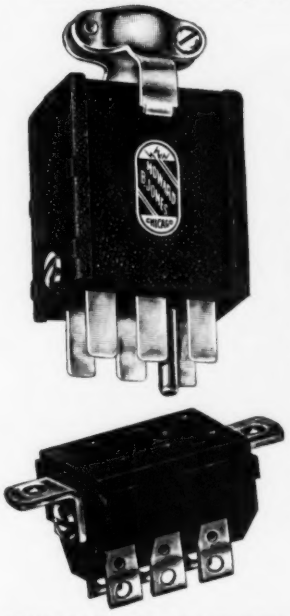

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